APPENDICES

APPENDIX A:

Geographic Information Systems
Map Data Sources

GEOGRAPHIC INFORMATION SYSTEM MAP DATA SOURCES

Figure 2. Coffee Creek watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set.

Figure 3. Little Calumet-Galien River watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road, stream, and county boundary coverages are from the U.S. Census Bureau TIGER data set. 8-digit and 14-digit watershed boundaries are from coverages created by the U.S. Geological Survey and Natural Resources Conservation Service in cooperation with Indiana Department of Environmental Management and Indiana Department of Natural Resources Division of Water.

Figure 4. Topographical relief of the Coffee Creek watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set. Relief coverage is the U.S. Geological Survey National Elevation Data set.

Figure 5. Highly Erodible Land in the Coffee Creek watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set. Highly Erodible Land (HEL) acreage digitized from Porter County NRCS map.

Figure 6. Historic land use in the Coffee Creek watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set. Historical land use digitized from McCartney, 1952.

Figure 7. Natural feature restorations and preserves in the Coffee Creek watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set. Natural features digitized from maps provided by the IDNR Division of Nature Preserves. Coffee Creek Watershed Preserve boundary provided by Lake Erie Land Company.

Figure 8. Endangered, threatened, and rare species in the Coffee Creek watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set. ETR

and special habitat locations digitized from maps provided by the IDNR Division of Nature Preserves.

Figure 9. National wetland inventory map.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set. Wetland location source is U.S. Fish and Wildlife Service National Wetland Inventory GIS coverage.

Figure 10. Historical structures and sites in the Coffee Creek watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set. Historic landmark sites digitized from Historic Landmarks Foundation of Indiana, 1991.

Figure 11. Land use in the Coffee Creek watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set. Land use comes from the USGS Indiana Land Cover Data Set. The data set was corrected based on field investigations conducted in 2002.

Figure 12. Sampling locations in the Coffee Creek watershed.
Watershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set.

Figure 13. Critical areas targeted for improvement by the Coffee Creek Watershed Management Plan.
Watershed and subwatershed boundaries generated using ArcView 3.3 Spatial Analyst with a hydrological modeling extension available from ESRI. Computer generated boundaries were field checked for accuracy. Road and stream coverages are from the U.S. Census Bureau TIGER data set.

APPENDIX B:

Press Releases

Press Release
For Immediate Release
Contact: Katie Rizer 926-1842

Public Meeting for 319 Grant

The Coffee Creek Watershed Conservancy, a non-profit 501 C3 organization, has received 319 grant funding through IDEM to develop a Watershed Management Plan for the watershed of Coffee Creek. The purpose of the grant is to document and describe the conditions and trends in the watershed, gather baseline biological and water quality data, identify nonpoint source water quality problems, and provide assistance and guidance to landowners within the watershed. The Watershed Management Plan will provide recommendations for specific direction of future work to protect and improve the quality of the creek. Coffee Creek begins south of US 6 and continues north to the Little Calumet River, just north of Chesterton. The 15 square mile watershed encompasses many public and private properties. A series of informational meetings will be held over the course of the next two years. The public is invited to participate, especially those directly adjacent to Coffee Creek. Public notices will be advertised in this newspaper and posted throughout the watershed in public areas. The IDEM 319 grant program is aimed at reducing nonpoint source water pollution but is not involved in or is authorized to enact legislation.

The first pubic meeting for the Coffee Creek Watershed Management Plan is scheduled for Tuesday, June 12, 2001 at 7:30pm at the Chesterton Library Service Center. All parties interested in the watershed are invited to attend.

The Coffee Creek Watershed Conservancy includes members of Save the Dunes Council, Shirley Heinze Environmental Fund, the Porter County Chapter of the Izaak Walton League, Northwest Indiana Steelheaders, and the Coffee Creek Life Center.

For further information about the grant contact either Katie Rizer, Executive Director of the Coffee Creek Watershed Conservancy at 219-926-1842 or Nicole Kalkbrenner, J.F. New and Associates at 219-586-3400 or nicole@jfnew.com.

Please join us for the second Public Meeting for the Coffee Creek Watershed Management Plan 319 Grant

The second pubic meeting for the Coffee Creek Watershed Management Plan is scheduled for Tuesday, September 4th, 2001 at 7:00pm at the Chesterton Library Service Center. All parties interested in the watershed are invited to attend.

The Coffee Creek Watershed Conservancy, a non-profit 501 C3 organization, has received 319 grant funding through IDEM to develop a Watershed Management Plan for the watershed of Coffee Creek. The purpose of the grant is to document and describe the conditions and trends in the watershed, gather baseline biological and water quality data, identify non-point source water quality problems, and provide assistance and guidance to landowners within the watershed. The Watershed Management Plan will provide recommendations for specific direction of future work to protect and improve the quality of the creek. Coffee Creek begins south of US 6 and continues north to the Little Calumet River, just north of Chesterton. The 15 square mile watershed encompasses many public and private properties. A series of informational meetings will be held over the course of the next two years. The public is invited to participate, especially those directly adjacent to Coffee Creek. Public notices will be advertised in this newspaper and posted throughout the watershed in public areas. The IDEM 319 grant program is aimed at reducing non-point source water pollution but is not involved in or is authorized to enact legislation.

The Coffee Creek Watershed Conservancy includes members of Save the Dunes Council, Shirley Heinze Environmental Fund, the Porter County Chapter of the Izaak Walton League, Northwest Indiana Steelheaders, Chesterton High School SAFE Club and the Coffee Creek Life Center.

For further information about the grant contact either Katie Rizer, Executive Director of the Coffee Creek Watershed Conservancy at 219-926-1842.

Please join us on December 4th, 2001 for the third Public Meeting for the Coffee Creek Watershed Management Plan 319 Grant

The third pubic meeting for the Coffee Creek Watershed Management Plan is scheduled for Wednesday December 4th, 2001 at 7:00pm at the Chesterton Library Service Center. All parties interested in the watershed are invited to attend. Guest speaker is Dan Ernst from the Forestry Division of DNR.

The Coffee Creek Watershed Conservancy, a non-profit 501 C3 organization, has received 319 grant funding through IDEM to develop a Watershed Management Plan for the watershed of Coffee Creek. The purpose of the grant is to document and describe the conditions and trends in the watershed, gather baseline biological and water quality data, identify non-point source water quality problems, and provide assistance and guidance to landowners within the watershed. The Watershed Management Plan will provide recommendations for specific direction of future work to protect and improve the quality of the creek. Coffee Creek begins south of US 6 and continues north to the Little Calumet River, just north of Chesterton. The 15 square mile watershed encompasses many public and private properties. A series of informational meetings will be held over the course of the next two years. The public is invited to participate, especially those directly adjacent to Coffee Creek. Public notices will be advertised in newspapers and posted throughout the watershed in public areas. The IDEM 319 grant program is aimed at reducing non-point source water pollution but is not involved in or is authorized to enact legislation.

The Coffee Creek Watershed Conservancy includes members of Save the Dunes Council, Shirley Heinze Environmental Fund, the Porter County Chapter of the Izaak Walton League, Northwest Indiana Steelheaders, Chesterton High School SAFE Club and the Coffee Creek Life Center.

For further information about the grant contact either Katie Rizer, Executive Director of the Coffee Creek Watershed Conservancy at 219-926-1842.

PRESS RELEASE
FOR IMMEDIATE RELEASE

June 19, 2002
CONTACT: KATIE RIZER
PHONE: (219) 926-1842

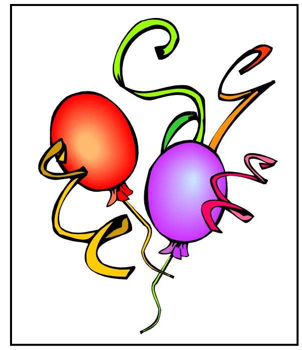
IDEM 319 GRANT
FIELD DAY AT THE HOMETOWN PICNIC

The Coffee Creek Watershed Conservancy will host field day tours at noon and 2:00 at the 4th Annual Hometown Picnic on June 22, 2002 at the Coffee Creek Watershed Preserve from 11:00 – 3:00. Join botonists as they lead tours highlighting the environmental restoration within the Coffee Creek Watershed Preserve.

The Coffee Creek Watershed Conservancy, a non-profit 501 C3 organization, has received 319 grant funding through IDEM to develop a Watershed Management Plan for the watershed of Coffee Creek. The purpose of the grant is to document and describe the conditions and trends in the watershed, gather baseline biological and water quality data, identify nonpoint source water quality problems, and provide assistance and guidance to landowners within the watershed. The Watershed Management Plan will provide recommendations for specific direction of future work to protect and improve the quality of the creek. Coffee Creek begins south of US 6 and continues north to the Little Calumet River, just north of Chesterton. The 15 square mile watershed encompasses many public and private properties. The IDEM 319 grant program is aimed at reducing nonpoint source water pollution but is not involved in or is authorized to enact legislation.

For additional information contact Katie Rizer, Executive Director of the CCWC at (219) 926-1842 or at Katie@coffeecreekwc.org

319 Grant – Field Day
at the
4th Annual Hometown Picnic
June 22, 2002
in the
Coffee Creek Watershed Preserve



What is a watershed management plan?
Where do you start and what results can you hope to achieve upon completion?
Join the Coffee Creek Watershed Conservancy, Inc. board of directors at the Hometown Picnic and see the results of a successful management plan in action during the field day tours at noon and 2:00 p.m.

While you're there, enjoy the musical entertainment at the Pavilion, the thrill of the Lion's Club Duck race in Coffee Creek as well as food, fun and games for all ages. No admission, free parking, free crafts and games for kids.
New this year: Arts & Crafts booths!

Press Release
For Immediate Release
September 4, 2002

Contact: Katie Rizer 926-1842

Public Meeting on Coffee Creek Watershed 319 Grant

The pubic is encouraged to attend a meeting for the Coffee Creek Watershed Management Plan scheduled for Monday, September 9th, 2002 at 7:00pm at the Westchester Public Library Service Center. All parties interested in the watershed are invited to attend.

The Coffee Creek Watershed Conservancy, a non-profit 501 C3 organization, has received 319 grant funding through IDEM to develop a Watershed Management Plan for the watershed of Coffee Creek. The purpose of the grant is to document and describe the conditions and trends in the watershed, gather baseline biological and water quality data, identify non-point source water quality problems, and provide assistance and guidance to landowners within the watershed.

The problem identification phase of the Coffee Creek watershed management plan has been completed. This includes analyzing the historic condition of the watershed through historical reports and characterizing the current conditions of the watershed through mapping, assessing habitat quality, and collecting water quality and macro invertebrate samples. As a result of this work, a comprehensive list of water quality and water quality-related concerns in the Coffee Creek watershed and its larger Little Calumet River basin has been compiled.

For further information regarding the 319 Grant contact Katie Rizer, Executive Director of the Coffee Creek Watershed Conservancy at 219-926-1842 or Katie@coffeecreekwc.org.

APPENDIX C:

Coffee Creek Watershed Major Stakeholders

MAJOR WATERSHED STAKEHOLDERS

Coffee Creek Watershed Conservancy
Contact: Katie Rizer
219 B South Calumet
Chesterton, IN 46304
219-926-1842
Katie@coffecreekwc.org

Save the Dunes Council
Contact: Tom Anderson
444 Barker Road
Michigan City, IN 46360
219-879-3937
std@savethedunes.org

Town of Chesterton
726 Broadway
Chesterton, IN 46304

Northwestern Indiana Regional Planning Commission
Contact: Jennifer Gadzala
6100 South Port Road
Portage, IN 46368
219-763-6060

Porter County Surveyor's Office
Contact: Kevin Breitzke
155 Indiana Avenue #303
Valparaiso, IN 46383

Indiana Department of Natural Resources
Division of Nature Preserves
Contact: Tom Post
5822 N. Fish and Wildlife Lane
Medaryville, IN 47957

Izaak Walton League, Porter County Chapter
Contact: Herb Read
Can be contacted through the CCWC.

Regional Watershed Conservationist
Natural Resources Conservation Service
Contact: Matt Jarvis
1523 N. US Highway 421, Suite 2
Delphi, Indiana 46923-9396.
(765) 564-4480
matt.jarvis@in.usda.gov

Porter County Natural Resources Conservation Service
Contact: Todd Ames
Eastport Tower-Suite
Valparaiso, IN 46383
219-464-1049
todd.ames@in.usda.gov

Indiana Department of Natural Resources
Lake Michigan Research Station
Contact: Brian Breidert
100 West Water Street
Michigan City, IN 46360
219-874-6824

Shirley Heinze Environmental Fund
Contact: Barbara Plampin
444 Barker Road
Michigan City, IN 46360
219-787-9438
shef@adsnet.com

Northwest Indiana Steelheaders
Contact: Mike Ryan
Can be contacted through the CCWC.

CHS S.A.F.E Club
Contact: Emily Rothenberger
Chesterton High School
Can be contacted through the CCWC.

APPENDIX D:

Endangered, Threatened, and Rare Species

February 26, 2002

ENDANGERED, THREATENED AND RARE SPECIES,
HIGH QUALITY NATURAL COMMUNITIES, AND SIGNIFICANT NATURAL AREAS DOCUMENTED
FROM THE COFFEE CREEK WATERSHED AREA, PORTER COUNTY, INDIANA

TYPE	SPECIES NAME	COMMON NAME	STATE	FED	LOCATION	DATE	COMMEN
MAP # 1							
Amphibian	NECTURUS MACULOSUS	MUDPUPPY	SSC	**	T36NR05W 06	1964	
MAP # 2							
Bird	DENDROICA CERULEA	CERULEAN WARBLER	SSC	**	T36NR05W 29 SEQ NWQ	1994	
Bird	WILSONIA CITRINA	HOODED WARBLER	SSC	**	T36NR05W 29 SEQ NWQ	1994	
Forest	FOREST - UPLAND DRY-MESIC	DRY-MESIC UPLAND FOREST	SG	**	T36NR05W 29	1985	
Forest	FOREST - UPLAND MESIC	MESIC UPLAND FOREST	SG	**	T36NR05W 29	1985	
Lake	LAKE - POND	POND	SG	**	T36NR05W 29	1985	
Vascular Plant	ARENARIA STRICTA	MICHAUX'S STITCHWORT	SR	**	T36NR05W 29	1975	
Vascular Plant	POTAMOGETON VASEYI	VASEY'S PONDWEED	SE	**	T36NR05W 29	1970	
Vascular Plant	SPARGANIUM ANDROCLADUM	BRANCHING BUR-REED	ST	**	T36NR05W 29	1970	
MAP # 3							
Vascular Plant	JUGLANS CINEREA	BUTTERNUT	WL	**	T36NR05W 20 SWQ SWQ NWQ	1999	
MAP # 4							
Vascular Plant	CYPRIPEDIUM CANDIDUM	SMALL WHITE LADY'S-SLIPPER	SR	**	T36NR05W 28 SEQ	1982	
MAP # 5							
Vascular Plant	CYPRIPEDIUM CALCEOLUS VAR	SMALL YELLOW LADY'S-SLIPPER	SR	**	T36NR05W 28 NWQ SEQ	1986	
Wetland	WETLAND - FEN	FEN	SG	**	T36NR05W 28 SEQ	1986	
Wetland	WETLAND - MEADOW SEDGE	SEDGE MEADOW	SG	**	T36NR05W 28 SEQ	1986	
MAP # 6							
Reptile	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	SE	**	T36NR05W 28 NWQ SEQ	1989	
Vascular Plant	CYPRIPEDIUM CANDIDUM	SMALL WHITE LADY'S-SLIPPER	SR	**	T36NR05W 28 NWQ SEQ	1986	
MAP # 7							
Wetland	WETLAND - SWAMP SHRUB	SHRUB SWAMP	SG	**	T36NR05W 29 WH NWQ	1985	
MAP # 8							
Bird	WILSONIA CITRINA	HOODED WARBLER	SSC	**	T36NR05W 29 SEQ SEQ	1994	
MAP # 9							
Vascular Plant	BOTRYCHIUM MATRICARIIFOLIUM	CHAMOMILE GRAPE-FERN	ST	**	T36NR05W 29 SEQ SWQ	1982	

STATE: SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC=special concern, WL=watch list, SG=significant,** no status but rarity warrants concern

FEDERAL: LE=endangered, LT=threatened, LELT=different listings for specific ranges of species, PE=proposed endangered, PT=proposed threatened, E/SA=appearance similar to LE species, **=not listed

ENDANGERED, THREATENED AND RARE SPECIES, HIGH QUALITY NATURAL COMMUNITIES, AND SIGNIFICANT NATURAL AREAS DOCUMENTED FROM THE COFFEE CREEK WATERSHED AREA, PORTER COUNTY, INDIANA

TYPE	SPECIES NAME	COMMON NAME	STATE	FED	LOCATION	DATE	COMMEN
MAP # 10							
Bird	DENDROICA CERULEA	CERULEAN WARBLER	SSC	**	T36NR05W 29 NWQ SWQ	1994	
Bird	WILSONIA CITRINA	HOODED WARBLER	SSC	**	T36NR05W 29 NWQ SWQ	1994	
MAP # 11							
Vascular Plant	CAREX LEPTONERVIA	FINELY-NERVED SEDGE	SE	**	T36NR05W 33 SWQ SEQ NWQ	1983	
MAP # 12							
Bird	DENDROICA CERULEA	CERULEAN WARBLER	SSC	**	T36NR05W 29 SWQ SWQ SEQ	1994	
Bird	WILSONIA CITRINA	HOODED WARBLER	SSC	**	T36NR05W 29 SWQ SWQ SEQ	1994	
MAP # 13							
Vascular Plant	LYCOPODIUM HICKEYI	HICKEY'S CLUBMOSS	SR	**	T35NR05W 04 NWQ NWQ SEQ	1989	
MAP # 14							
Bird	DENDROICA CERULEA	CERULEAN WARBLER	SSC	**	T36NR05W 29 SWQ NWQ	1994	
MAP # 15							
Vascular Plant	ERIOCAULON AQUATICUM	PIPEWORT	SE	**	T36NR06W MUD LAKE AREA.	1916	
MAP # 16							
Bird	DENDROICA CERULEA	CERULEAN WARBLER	SSC	**	T36NR05W 29 SEQ NWQ	1994	
MAP # 17							
Bird	ARDEA HERODIAS	GREAT BLUE HERON	**	**	T35NR05W 04 SWQ	1999	
MAP # 18							
Bird	DENDROICA CERULEA	CERULEAN WARBLER	SSC	**	T36NR05W 32 NWQ NEQ NWQ	1994	
Vascular Plant	CHRYSOSPLENIUM AMERICANUM	AMERICAN GOLDEN-SAXIFRAGE	ST	**	T36NR05W 33 SWQ NEQ	1998	
MAP # 19							
Bird	CISTOTHORUS PLATENSIS	SEDGE WREN	SE	**	T36NR05W 33 NWQ NEQ	1994	
MAP # 20							
Bird	CISTOTHORUS PLATENSIS	SEDGE WREN	SE	**	T36NR05W 33 NEQ SWQ	1994	
MAP # 21							
Amphibian	RANA PIPIENS	NORTHERN LEOPARD FROG	SSC	**	T36NR06W COFFEE CREEK AT CHESTERTON	1939	

STATE: SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC=special concern, WL=watch list, SG=significant,** no status but rarity warrants concern

FEDERAL: LE=endangered, LT=threatened, LELT=different listings for specific ranges of species, PE=proposed endangered, PT=proposed threatened, E/SA=appearance similar to LE species, **=not listed

ENDANGERED, THREATENED AND RARE SPECIES,
HIGH QUALITY NATURAL COMMUNITIES, AND SIGNIFICANT NATURAL AREAS DOCUMENTED
FROM THE COFFEE CREEK WATERSHED AREA, PORTER COUNTY, INDIANA

TYPE	SPECIES NAME	COMMON NAME	STATE	FED	LOCATION	DATE	COMMEN
Bird	IXOBRYCHUS EXILIS	LEAST BITTERN	SE	**	CHESTERTON AREA	1940	
Bird	LANIUS LUDOVICIANUS	LOGGERHEAD SHRIKE	SE	**	CHESTERTON AREA.	1951	
Reptile	CLEMMYS GUTTATA	SPOTTED TURTLE	SE	**	T36NR06W COFFEE CREEK AT CHESTERTON	1939	
MAP # **22**							
Reptile	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	SE	**	T36NR05W 29 SEQ SWQ NWQ	1987	

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ENDANGERED, THREATENED AND RARE SPECIES DOCUMENTED FROM PORTER COUNTY, INDIANA

SPECIES NAME	COMMON NAME	STATE	FED	SRANK	GRANK
VASCULAR PLANT					
ACTAEA RUBRA	RED BANEBERRY	SR	**	S2	G5
AMELANCHIER HUMILIS	RUNNING SERVICEBERRY	SE	**	S1	G5
ARABIS GLABRA	TOWER-MUSTARD	ST	**	S2	G5
ARALIA HISPIDA	BRISTLY SARSAPARILLA	SE	**	S1	G5
ARCTOSTAPHYLOS UVA-URSI	BEARBERRY	SR	**	S2	G5
ARENARIA STRICTA	MICHAUX'S STITCHWORT	SR	**	S2	G5
ARISTIDA INTERMEDIA	SLIM-SPIKE THREE-AWN GRASS	SR	**	S2	G?
ARISTIDA TUBERCULOSA	SEABEACH NEEDLEGRASS	SR	**	S2	G5
ASTER BOREALIS	RUSHLIKE ASTER	SR	**	S2	G5
ASTER FURCATUS	FORKED ASTER	SR	**	S2	G3
ASTER SERICEUS	WESTERN SILVERY ASTER	SR	**	S2	G5
BETULA POPULIFOLIA	GRAY BIRCH	SX	**	SX	G5
BOTRYCHIUM MATRICARIIFOLIUM	CHAMOMILE GRAPE-FERN	ST	**	S2	G5
BOTRYCHIUM MULTIFIDUM VAR INTERMEDIUM	LEATHERY GRAPE-FERN	SX	**	SX	G5T4?
BUCHNERA AMERICANA	BLUEHEARTS	SE	**	S1	G5?
CAREX ATHERODES	AWNED SEDGE	SE	**	S1	G5
CAREX ATLANTICA SSP CAPILLACEA	HOWE SEDGE	SE	**	S1	G5T5?
CAREX AUREA	GOLDEN-FRUITED SEDGE	SR	**	S2	G5
CAREX BRUNNESCENS	BROWNISH SEDGE	SE	**	S1	G5
CAREX CONOIDEA	PRAIRIE GRAY SEDGE	SE	**	S1	G4
CAREX DEBILIS VAR RUDGEI	WHITE-EDGE SEDGE	ST	**	S2	G5T5
CAREX EBURNEA	EBONY SEDGE	SR	**	S2	G5
CAREX FLAVA	YELLOW SEDGE	ST	**	S2	G5
CAREX FOLLICULATA	LONG SEDGE	ST	**	S2	G4G5
CAREX GARBERI	ELK SEDGE	ST	**	S2	G4
CAREX LEPTONERVIA	FINELY-NERVED SEDGE	SE	**	S1	G4
CAREX LIMOSA	MUD SEDGE	SE	**	S1	G5
CAREX PEDUNCULATA	LONGSTALK SEDGE	SR	**	S2	G5
CAREX SEORSA	WEAK STELLATE SEDGE	SR	**	S2	G4
CHIMAPHILA UMBELLATA SSP CISATLANTICA	PIPSISSEWA	ST	**	S2	G5T5
CHRYSOSPLENIUM AMERICANUM	AMERICAN GOLDEN-SAXIFRAGE	ST	**	S2	G5
CIRCAEA ALPINA	SMALL ENCHANTER'S NIGHTSHADE	SX	**	SX	G5
CIRSIUM HILLII	HILL'S THISTLE	SE	**	S1	G3
CIRSIUM PITCHERI	DUNE THISTLE	ST	LT	S2	G3
CLINTONIA BOREALIS	CLINTON LILY	SE	**	S1	G5
COELOGLOSSUM VIRIDE VAR VIRESCENS	LONG-BRACT GREEN ORCHIS	ST	**	S2	G5T5
CORNUS AMOMUM SSP AMOMUM	SILKY DOGWOOD	SE	**	S1	G5T?
CORNUS CANADENSIS	BUNCHBERRY	SE	**	S1	G5
CORNUS RUGOSA	ROUNDLEAF DOGWOOD	SR	**	S2	G5
CYPERUS HOUGHTONII	HOUGHTON'S NUTSEDGE	SR	**	S2	G4?
CYPRIPEDIUM CALCEOLUS VAR PARVIFLORUM	SMALL YELLOW LADY'S-SLIPPER	SR	**	S2	G5
CYPRIPEDIUM CANDIDUM	SMALL WHITE LADY'S-SLIPPER	SR	**	S2	G4

STATE: SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC=special concern, WL=watch list, SG=significant,** no status but rarity warrants concern

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ENDANGERED, THREATENED AND RARE SPECIES DOCUMENTED FROM PORTER COUNTY, INDIANA

SPECIES NAME	COMMON NAME	STATE	FED	SRANK	GRANK
DIERVILLA LONICERA	NORTHERN BUSH-HONEYSUCKLE	SR	**	S2	G5
DROSERA INTERMEDIA	SPOON-LEAVED SUNDEW	SR	**	S2	G5
DRYOPTERIS CLINTONIANA	CLINTON WOODFERN	SX	**	SX	G5
ELEOCHARIS GENICULATA	CAPITATE SPIKE-RUSH	ST	**	S2	G5
ELEOCHARIS MELANOCARPA	BLACK-FRUITED SPIKE-RUSH	ST	**	S2	G4
ELEOCHARIS MICROCARPA	SMALL-FRUITED SPIKE-RUSH	SE	**	S1	G5
ELEOCHARIS ROBBINSII	ROBBINS SPIKERUSH	SR	**	S2	G4G5
ERIOCAULON AQUATICUM	PIPEWORT	SE	**	S1	G5
ERIOPHORUM ANGUSTIFOLIUM	NARROW-LEAVED COTTON-GRASS	SR	**	S2	G5
FIMBRISTYLIS PUBERULA	CAROLINA FIMBRY	SE	**	S1	G5
FUIRENA PUMILA	DWARF UMBRELLA-SEDGE	ST	**	S2	G4
GENTIANA ALBA	YELLOW GENTIAN	SR	**	S2	G4
GENTIANA PUBERULENTA	DOWNY GENTIAN	ST	**	S2	G4G5
GERANIUM BICKNELLII	BICKNELL NORTHERN CRANE'S-BILL	SE	**	S1	G5
HUDSONIA TOMENTOSA	SAND-HEATHER	ST	**	S2	G5
HYPERICUM ADPRESSUM	CREEPING ST. JOHN'S-WORT	SE	**	S1	G2G3
HYPERICUM PYRAMIDATUM	GREAT ST. JOHN'S-WORT	SE	**	S1	G4
JUGLANS CINEREA	BUTTERNUT	WL	**	S3	G3G4
JUNCUS ARTICULATUS	JOINTED RUSH	SE	**	S1	G5
JUNCUS BALTICUS VAR LITTORALIS	BALTIC RUSH	SR	**	S2	G5T5
JUNCUS MILITARIS	BAYONET RUSH	SE	**	S1	G4
JUNCUS PELOCARPUS	BROWN-FRUITED RUSH	ST	**	S2	G5
JUNCUS SCIRPOIDES	SCIRPUS-LIKE RUSH	ST	**	S2	G5
JUNIPERUS COMMUNIS	GROUND JUNIPER	SR	**	S2	G5
LATHYRUS MARITIMUS VAR GLABER	BEACH PEAVINE	SE	**	S1	G5T4T5
LATHYRUS OCHROLEUCUS	PALE VETCHLING PEAVINE	SE	**	S1	G4G5
LATHYRUS VENOSUS	SMOOTH VEINY PEA	ST	**	S2	G5
LECHEA STRICTA	UPRIGHT PINWEED	SX	**	SX	G4?
LEMNA VALDIVIANA	PALE DUCKWEED	SX	**	SX	G5
LINNAEA BOREALIS	TWINFLOWER	SX	**	SX	G5
LUDWIGIA SPHAEROCARPA	GLOBE-FRUITED FALSE-LOOSESTRIFE	SE	**	S1	G5
LYCOPODIELLA INUNDATA	NORTHERN BOG CLUBMOSS	SE	**	S1	G5
LYCOPODIELLA SUBAPPRESSA	NORTHERN APPRESSED BOG CLUBMOSS	SE	**	S1	G2
LYCOPODIUM HICKEYI	HICKEY'S CLUBMOSS	SR	**	S2	G5
LYCOPODIUM OBSCURUM	TREE CLUBMOSS	SR	**	S2	G5
LYCOPODIUM TRISTACHYUM	DEEP-ROOT CLUBMOSS	ST	**	S2	G5
MELAMPYRUM LINEARE	AMERICAN COW-WHEAT	SR	**	S2	G5
MIKANIA SCANDENS	CLIMBING HEMPWEED	SE	**	S1	G5
MILIUM EFFUSUM	TALL MILLET-GRASS	SR	**	S2	G5
MYOSOTIS LAXA	SMALLER FORGET-ME-NOT	SE	**	S1	G5
OROBANCHE FASCICULATA	CLUSTERED BROOMRAPE	SE	**	S1	G4
ORYZOPSIS ASPERIFOLIA	WHITE-GRAINED MOUNTAIN-RICEGRASS	SE	**	S1	G5
ORYZOPSIS PUNGENS	SLENDER MOUNTAIN-RICEGRASS	SX	**	SX	G5

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SPECIES NAME	COMMON NAME	STATE	FED	SRANK	GRANK
ORYZOPSIS RACEMOSA	BLACK-FRUIT MOUNTAIN-RICEGRASS	ST	**	S2	G5
PANICUM BOREALE	NORTHERN WITCHGRASS	SR	**	S2	G5
PANICUM COLUMBIANUM	HEMLOCK PANIC-GRASS	SR	**	S2	G5
PANICUM LEIBERGII	LEIBERG'S WITCHGRASS	ST	**	S2	G5
PANICUM MATTAMUSKEETENSE	A PANIC-GRASS	SX	**	SX	G?
PANICUM VERRUCOSUM	WARTY PANIC-GRASS	ST	**	S2	G4
PINUS BANKSIANA	JACK PINE	SR	**	S2	G5
PINUS STROBUS	EASTERN WHITE PINE	SR	**	S2	G5
PLANTAGO CORDATA	HEART-LEAVED PLANTAIN	SE	**	S1	G4
PLATANTHERA CILIARIS	YELLOW-FRINGE ORCHIS	SE	**	S1	G5
PLATANTHERA HOOKERI	HOOKER ORCHIS	SX	**	SX	G5
PLATANTHERA HYPERBOREA	LEAFY NORTHERN GREEN ORCHIS	ST	**	S2	G5
PLATANTHERA PSYCODES	SMALL PURPLE-FRINGE ORCHIS	SR	**	S2	G5
POA ALSODES	GROVE MEADOW GRASS	SR	**	S2	G4G5
POA PALUDIGENA	BOG BLUEGRASS	WL	**	S3	G3
POLYGALA PAUCIFOLIA	GAY-WING MILKWORT	SE	**	S1	G5
POLYGONELLA ARTICULATA	EASTERN JOINTWEED	SR	**	S2	G5
POLYGONUM CAREYI	CAREY'S SMARTWEED	ST	**	S2	G4
POLYGONUM HYDROPIPEROIDES VAR OPELOUSANUM	NORTHEASTERN SMARTWEED	ST	**	S2	G5
POPULUS BALSAMIFERA	BALSAM POPLAR	SX	**	SX	G5
POTAMOGETON RICHARDSONII	REDHEADGRASS	ST	**	S2	G5
POTAMOGETON VASEYI	VASEY'S PONDWEED	SE	**	S1	G4
POTENTILLA ANSERINA	SILVERWEED	ST	**	S2	G5
PRUNUS PENSYLVANICA	FIRE CHERRY	SR	**	S2	G5
PSILOCARYA NITENS	SHORT-BEAKED BALD-RUSH	SX	**	SX	G4
PSILOCARYA SCIRPOIDES	LONG-BEAKED BALDRUSH	ST	**	S2	G4
PYROLA ROTUNDIFOLIA VAR AMERICANA	AMERICAN WINTERGREEN	SR	**	S2	G5
PYROLA SECUNDA	ONE-SIDED WINTERGREEN	SX	**	SX	G5
RHUS AROMATICA VAR ARENARIA	BEACH SUMAC	ST	**	S2	G5T3Q
RHYNCHOSPORA GLOBULARIS VAR RECOGNITA	GLOBE BEAKED-RUSH	SE	**	S1	G5T5?
RHYNCHOSPORA MACROSTACHYA	TALL BEAKED-RUSH	SR	**	S2	G4
SALIX CORDATA	HEARTLEAF WILLOW	ST	**	S2	G5
SCIRPUS EXPANSUS	BULRUSH	SE	**	S1	G4
SCIRPUS HALLII	HALL'S BULRUSH	SE	**	S1	G2
SCIRPUS PURSHIANUS	WEAKSTALK BULRUSH	SE	**	S1	G4G5
SCIRPUS SMITHII	SMITH'S BULRUSH	SE	**	S1	G5?
SCIRPUS SUBTERMINALIS	WATER BULRUSH	SR	**	S2	G4G5
SCIRPUS TORREYI	TORREY'S BULRUSH	SE	**	S1	G5?
SCLERIA RETICULARIS	RETICULATED NUTRUSH	ST	**	S2	G3G4
SELAGINELLA RUPESTRIS	LEDGE SPIKE-MOSS	ST	**	S2	G5
SISYRINCHIUM MONTANUM	STRICT BLUE-EYED-GRASS	SE	**	S1	G5
SOLIDAGO PTARMICOIDES	PRAIRIE GOLDENROD	SR	**	S2	G5

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SPECIES NAME	COMMON NAME	STATE	FED	SRANK	GRANK
SOLIDAGO SIMPLEX VAR GILLMANII	STICKY GOLDENROD	ST	**	S2	G5T3?
SORBUS DECORA	NORTHERN MOUNTAIN-ASH	SX	**	SX	G4G5
SPARGANIUM ANDROCLADUM	BRANCHING BUR-REED	ST	**	S2	G4G5
SPIRANTHES LUCIDA	SHINING LADIES'-TRESSES	SR	**	S2	G5
STIPA AVENACEA	BLACKSEED NEEDLEGRASS	ST	**	S2	G5
TALINUM RUGOSPERMUM	PRAIRIE FAME-FLOWER	ST	**	S2	G3?
THALICTRUM PUBESCENS	TALL MEADOWRUE	ST	**	S2	G5
THUJA OCCIDENTALIS	NORTHERN WHITE CEDAR	SE	**	S1	G5
TRICHOSTEMA DICHOTOMUM	FORKED BLUECURL	SR	**	S2	G5
TRILLIUM CERNUUM VAR MACRANTHUM	NODDING TRILLIUM	SE	**	S1	G5T4
UTRICULARIA CORNUTA	HORNED BLADDERWORT	ST	**	S2	G5
UTRICULARIA MINOR	LESSER BLADDERWORT	SE	**	S1	G5
UTRICULARIA PURPUREA	PURPLE BLADDERWORT	SR	**	S2	G5
UTRICULARIA SUBULATA	ZIGZAG BLADDERWORT	ST	**	S2	G5
VACCINIUM OXYCOCCOS	SMALL CRANBERRY	ST	**	S2	G5
VALERIANELLA CHENOPODIIFOLIA	GOOSE-FOOT CORN-SALAD	SE	**	S1	G5
VERONICA ANAGALLIS-AQUATICA	BROOK-PIMPERNELL	ST	**	S2	G5
VIBURNUM OPULUS VAR AMERICANUM	HIGHBUSH-CRANBERRY	SE	**	S1	G5T5
VIOLA PRIMULIFOLIA	PRIMROSE-LEAF VIOLET	SR	**	S2	G5
WOODWARDIA AREOLATA	NETTED CHAINFERN	SR	**	S2	G5
XYRIS DIFFORMIS	CAROLINA YELLOW-EYED GRASS	ST	**	S2	G5
ARTHROPODA: INSECTA: ODONATA (DRAGONFLIES; DAMSELFLIES)					
SYMPETRUM SEMICINCTUM	BAND-WINGED MEADOWFLY	**	**	S2S3	G5
ARTHROPODA: INSECTA: COLEOPTERA (BEETLES)					
NICROPHORUS AMERICANUS	AMERICAN BURYING BEETLE	SX	LE	SH	G1
ARTHROPODA: INSECTA: LEPIDOPTERA (BUTTERFLIES; SKIPPERS)					
CALLOPHRYS IRUS	FROSTED ELFIN	SR	**	S2	G3G4
ERYNNIS MARTIALIS	MOTTLED DUSKYWING	ST	**	S3	G4
EUCHLOE OLYMPIA	OLYMPIA MARBLEWING	ST	**	S2	G4
HESPERIA LEONARDUS	LEONARDUS SKIPPER	SR	**	S2	G4
LYCAEIDES MELISSA SAMUELIS	KARNER BLUE BUTTERFLY	SE	LE	S1	G5T2
POANES VIATOR VIATOR	BIG BROAD-WINGED SKIPPER	SR	**	S2	G5T4
PROBLEMA BYSSUS	BUNCHGRASS SKIPPER	SR	**	S2	G3G4
ARTHROPODA: INSECTA: LEPIDOPTERA (MOTHS)					
SCHINIA INDIANA	PHLOX MOTH	SE	**	S1	GU
FISH					
ACIPENSER FULVESCENS	LAKE STURGEON	SE	**	S1	G3

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AMPHIBIANS					
AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	SSC	**	S2	G5
HEMIDACTYLIUM SCUTATUM	FOUR-TOED SALAMANDER	SE	**	S2	G5
NECTURUS MACULOSUS	MUDPUPPY	SSC	**	S2	G5
RANA PIPIENS	NORTHERN LEOPARD FROG	SSC	**	S2	G5
REPTILES					
CLEMMYS GUTTATA	SPOTTED TURTLE	SE	**	S2	G5
CLONOPHIS KIRTLANDII	KIRTLAND'S SNAKE	SE	**	S2	G2
EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	SE	**	S2	G4
LIOCHLOROPHIS VERNALIS	SMOOTH GREEN SNAKE	SE	**	S2	G5
OPHISAURUS ATTENUATUS	SLENDER GLASS LIZARD	**	**	S2	G5
SISTRURUS CATENATUS CATENATUS	EASTERN MASSASAUGA	SE	**	S2	G3G4T3T4
THAMNOPHIS BUTLERI	BUTLER'S GARTER SNAKE	SE	**	S1	G4
THAMNOPHIS PROXIMUS	WESTERN RIBBON SNAKE	SSC	**	S3	G5
BIRDS					
AMMODRAMUS HENSLOWII	HENSLOW'S SPARROW	SE	**	S3B,SZN	G4
ARDEA ALBA	GREAT EGRET	SSC	**	S1B,SZN	G5
ARDEA HERODIAS	GREAT BLUE HERON	**	**	S4B,SZN	G5
ASIO OTUS	LONG-EARED OWL	**	**	S2	G5
BARTRAMIA LONGICAUDA	UPLAND SANDPIPER	SE	**	S3B	G5
BOTAURUS LENTIGINOSUS	AMERICAN BITTERN	SE	**	S2B	G4
BUTEO LINEATUS	RED-SHOULDERED HAWK	SSC	**	S3	G5
BUTEO PLATYPTERUS	BROAD-WINGED HAWK	SSC	**	S3B,SRFN	G5
CIRCUS CYANEUS	NORTHERN HARRIER	SE	**	S2	G5
CISTOTHORUS PALUSTRIS	MARSH WREN	SE	**	S3B,SZN	G5
CISTOTHORUS PLATENSIS	SEDGE WREN	SE	**	S3B,SZN	G5
DENDROICA CERULEA	CERULEAN WARBLER	SSC	**	S3B	G4
FALCO PEREGRINUS	PEREGRINE FALCON	SE	E(S/A)	S2B,SZN	G4
IXOBRYCHUS EXILIS	LEAST BITTERN	SE	**	S3B	G5
LANIUS LUDOVICIANUS	LOGGERHEAD SHRIKE	SE	**	S3B,SZN	G5
MNIOTILTA VARIA	BLACK-AND-WHITE WARBLER	SSC	**	S1S2B	G5
NYCTICORAX NYCTICORAX	BLACK-CROWNED NIGHT-HERON	SE	**	S1B,SAN	G5
RALLUS ELEGANS	KING RAIL	SE	**	S1B,SZN	G4G5
RALLUS LIMICOLA	VIRGINIA RAIL	SSC	**	S3B,SZN	G5
STURNELLA NEGLECTA	WESTERN MEADOWLARK	SSC	**	S2B	G5
VERMIVORA CHRYSOPTERA	GOLDEN-WINGED WARBLER	SE	**	S1B	G4
WILSONIA CANADENSIS	CANADA WARBLER	**	**	S2B	G5
WILSONIA CITRINA	HOODED WARBLER	SSC	**	S3B	G5
MAMMALS					

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SPECIES NAME	COMMON NAME	STATE	FED	SRANK	GRANK
SPERMOPHILUS FRANKLINII	FRANKLIN'S GROUND SQUIRREL	SE	**	S2	G5
TAXIDEA TAXUS	AMERICAN BADGER	SE	**	S2	G5
HIGH QUALITY NATURAL COMMUNITY					
FOREST - UPLAND DRY	DRY UPLAND FOREST	SG	**	S4	G4
FOREST - UPLAND DRY-MESIC	DRY-MESIC UPLAND FOREST	SG	**	S4	G4
FOREST - UPLAND MESIC	MESIC UPLAND FOREST	SG	**	S3	G3?
LAKE - LAKE	LAKE	SG	**	S2	
LAKE - POND	POND	SG	**	S?	
PRAIRIE - DRY-MESIC	DRY-MESIC PRAIRIE	SG	**	S2	G3
PRAIRIE - MESIC	MESIC PRAIRIE	SG	**	S2	G2
PRAIRIE - SAND DRY	DRY SAND PRAIRIE	SG	**	S2	G3
PRAIRIE - SAND DRY-MESIC	DRY-MESIC SAND PRAIRIE	SG	**	S3	G3
PRAIRIE - SAND WET-MESIC	WET-MESIC SAND PRAIRIE	SG	**	S2	G1?
PRAIRIE - WET	WET PRAIRIE	SG	**	S1	G3
PRIMARY - DUNE LAKE	FOREDUNE	SG	**	S1	G3
SAVANNA - SAND DRY	DRY SAND SAVANNA	SG	**	S2	G2?
SAVANNA - SAND DRY-MESIC	DRY-MESIC SAND SAVANNA	SG	**	S2S3	G2?
WETLAND - FEN	FEN	SG	**	S3	G3
WETLAND - FEN FORESTED	FORESTED FEN	SG	**	S1	G3
WETLAND - MARSH	MARSH	SG	**	S4	GU
WETLAND - MEADOW SEDGE	SEDGE MEADOW	SG	**	S1	G3?
WETLAND - PANNE	PANNE	SG	**	S1	G2
WETLAND - SWAMP SHRUB	SHRUB SWAMP	SG	**	S2	GU

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APPENDIX E:

Subwatershed Land Use

Land Use	Suman Road Tributary Subwatershed (acres)	Shooter Ditch Subwatershed (acres)	Pope O'Connor Ditch Subwatershed (acres)	Johnson Ditch Subwatershed (acres)
Deciduous forest	271.0	64.6	325.9	235.3
Evergreen forest	269.9	22.5	90.6	186.9
Emergent herbaceous wetlands	45.7	2.0	86.6	14.4
Woody wetlands	81.0	5.8	65.4	72.9
Grassland/herbaceous	85.4	63.8	74.4	55.7
Other grasses	16.4	0.0	85.0	79.9
Open water	14.1	0.0	20.3	6.3
Pasture/hay	192.2	121.0	181.9	70.8
Row crop agriculture	102.9	165.0	232.8	0.2
High intensity residential	0.8	0.0	48.1	1.3
Low intensity residential	58.0	15.8	167.0	2.4
High intensity commercial	15.8	7.3	53.7	11.5
Totals	**1153.2**	**467.7**	**1431.6**	**737.7**

APPENDIX F:

Water Quality Assessment

WATER QUALITY ASSESSMENT

Introduction

Watershed stakeholders must understand a stream's existing water quality before they can develop a management plan for that stream. It is the stream's current condition that directs any management actions employed by the stakeholders. For example if a given stream possesses good water quality, stakeholders should focus limited resources (financial, time, manpower, etc.) on protection activities. Similarly, stakeholders might pursue restoration strategies to improve streams with degraded water quality. The stream's current condition also provides the baseline conditions from which stakeholders can establish goals for protection or improvement of the stream. Finally, the stream's current conditions will serve as a benchmark against which stakeholders can measure their progress toward achieving those goals. For these reasons, establishing a stream's existing condition is of vital importance in developing a watershed management plan.

There are a variety of means available to assess the existing water quality of a stream. Two of the more common methods are analyzing water samples for an array of chemical and physical parameters and surveying the stream's biological community. Historically, regulatory agencies and watershed managers have relied on the collection of water samples to evaluate the water quality of a stream. The ease of collection and relative short time frame in which many water samples can be collected and analyzed make this an attractive method of evaluating a stream's water quality. The primary drawback to this evaluation is that grab samples collected from a stream's water column provide a one-time snapshot of the stream's water quality at the time of sampling. If that snapshot is not representative of the typical water quality conditions in the stream, the overall assessment of the stream may not be accurate.

To avoid this problem, more and more researchers, natural resources agencies, and watershed managers are using biological indices to evaluate a stream's water quality. A biological index examines various characteristic of a stream's biotic community (usually fish or macroinvertebrates, less commonly algae). The characteristics examined often include the community's diversity (i.e number of taxa and the evenness with which taxa are distributed), composition (i.e. number of pollution sensitive taxa vs. number of pollutant tolerant taxa), and condition. As water quality in a stream changes, these characteristics also change. For example, as water quality degrades, pollution tolerant taxa begin to dominate and pollution sensitive taxa become rare. By evaluating the biotic community's characteristics, one can understand the cumulative effects of water quality in a stream. In essence, because the stream's biotic community integrates the effects of the stream's water chemistry over time, use of a biotic index avoids the "one-time snapshot" problem inherent in collecting water chemistry grab samples.

Assessing water quality by evaluating the stream's biota is not without its drawbacks. The array of fish, invertebrates, and algae found in a stream is a result of many different major factors. In addition to water quality, habitat quality, energy, flow regime, and biological pressures (predation, parasitism, competition, etc.) shape a stream's biological communities (Karr et al., 1986). For example, a stream fish community dominated by very tolerant fish does not necessarily mean the water quality is very poor. Lack of appropriate spawning habitat or changes in the stream's hydrological regime could play a larger role in shaping the stream's fish community than water quality in some instances.

To provide a complete assessment of the water quality in Coffee Creek and its tributaries, the creek system's water chemistry, macroinvertebrate community, and habitat were assessed. Collection of water quality samples occurred four times, sampling during the growing season and dormant season and under base flow and storm flow hydrological conditions. To avoid the "one-time snapshot" associated with water chemistry collection, the macroinvertebrate community in Coffee Creek and its tributaries were assessed twice: once during late spring/early summer and once during the fall to capture the two diversity peaks. The in-stream and riparian habitat along Coffee Creek and its tributaries was also evaluated to help in isolating which factors are responsible for shaping the creek and tributaries' biotic communities. This assessment will serve as a foundation on which stakeholders can start developing water quality goals for the Coffee Creek watershed. The assessment will also provide benchmark conditions against which stakeholders can measure their progress toward achieving their goals.

Water Chemistry Assessment

Water Chemistry Methods

Grab samples were collected from eight sampling sites (Figure 1; Table 1) in the Coffee Creek watershed four times during the study period. Water quality sample collection and analysis followed the methodologies outlined in the Coffee Creek Watershed Quality Assurance Project Plan (Appendix F). The specifics of these methodologies will not be repeated here. Three of the sampling events occurred following periods of minimal precipitation; these were the first two sampling efforts which occurred on September 27, 2001 and February 14, 2002 and the fourth sampling effort on July 29, 2002. The hydrograph for the United States Geological Survey (USGS) Little Calumet River gaging station shows discharge at the gage was below the historical median discharge for the final sampling event (Figure 2). (The historical median is based on 56 years worth of data.) This data suggests streams in the watershed were at base flow conditions July 29, 2002. Although not shown here, the hydrographs for the September 27, 2001 and February 14, 2002 sampling events illustrate that sample collection occurred during base flow conditions as well. Base flow sampling provides an understanding of typical conditions in streams.

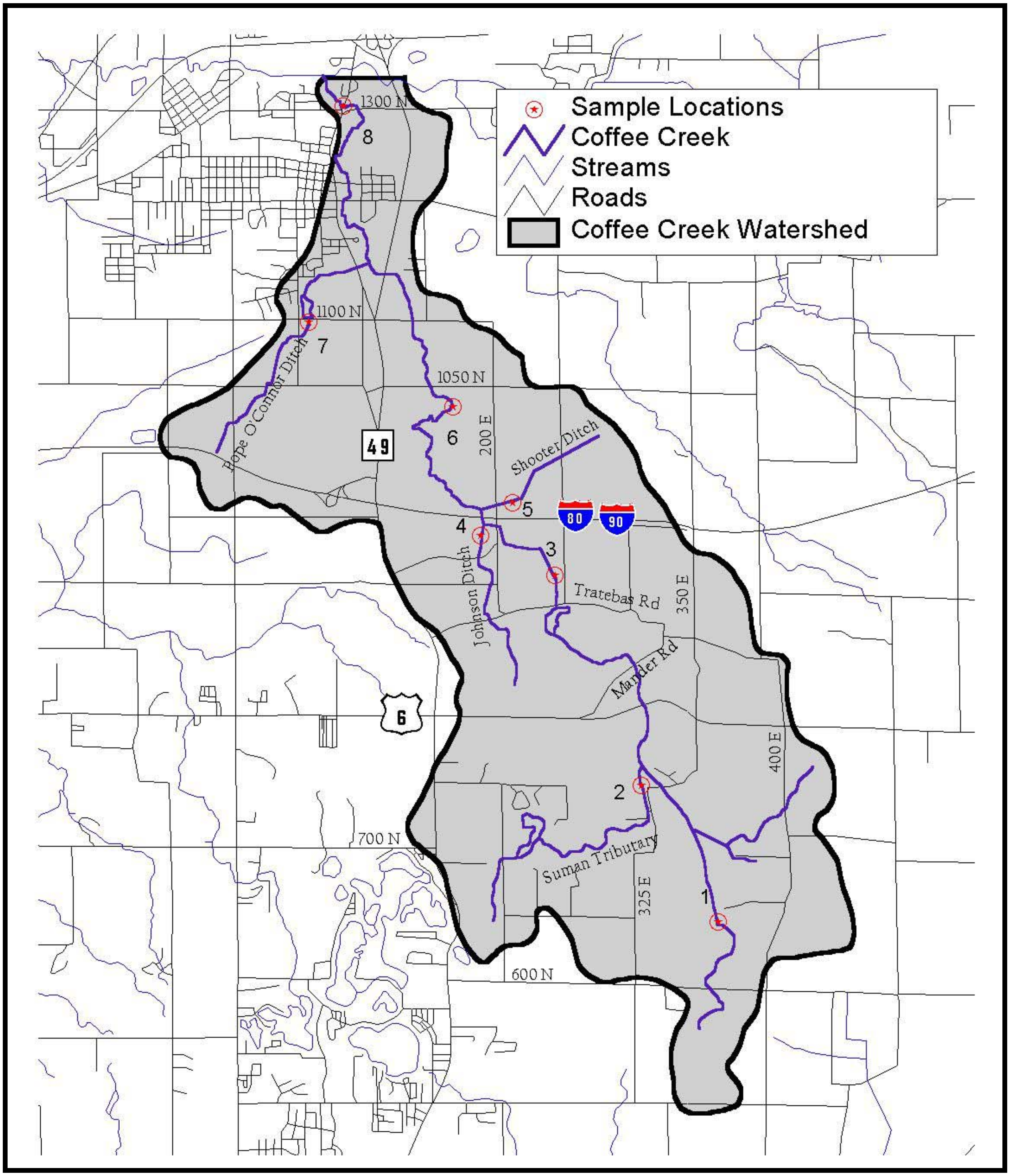

Figure 1. Sampling locations in the Coffee Creek watershed.

Table 1. Detailed sampling location information for the Coffee Creek watershed.

Site #	Stream Name	Road Location	Place Sampled
1	Coffee Creek	Old State Road 49 immediately north of Indiana Boundary Road	upstream of Old State Road 49
2	Pope O'Connor Ditch	CR 1100 North immediately east of 5th Street	downstream of CR 1100 North
3	Coffee Creek	within Coffee Creek Center	1200' feet upstream of CR 1050 North
4	Shooter Ditch	east of CR 200 East and north of I-80/90	near eastern edge of property boundary
5	Johnson Ditch	dead end gravel road west of CR 200 East and south of I-80/90	upstream of road crossing
6	Coffee Creek	intersection of Mander Road	upstream of road crossing
7	Suman Road Tributary	near a 90-degree bend in Suman Road north of CR 700 North	upstream of road access point
8	Coffee Creek	within the St. Andrews residential development	lot number 21 downstream of bridge

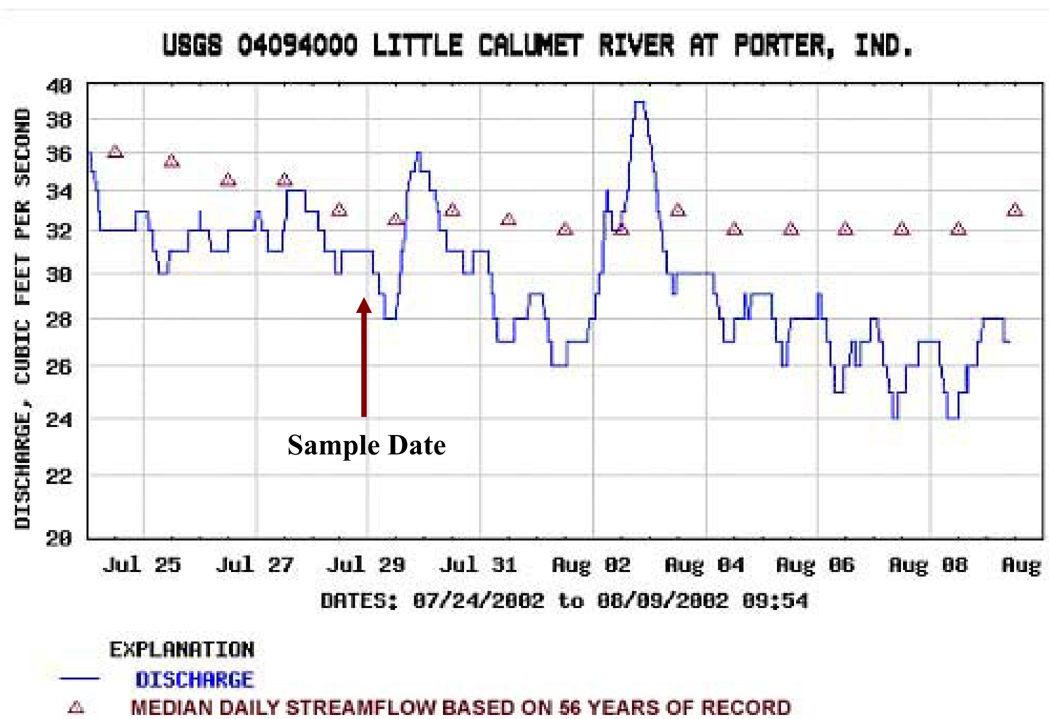

Figure 2. Mean daily discharge for the Little Calumet River at Porter, Indiana. The arrow marks the discharge on July 29, 2002. Discharge on the sampling date was below the 53-year median stream flow. Source: USGS, 2002.

The third sampling effort occurred on April 9, 2002 following two days of rain. Local monitoring stations reported precipitation totals of approximately one inch in Valparaiso (Purdue Applied Meteorology Group, 2002). Discharge at the Little Calumet River gaging station exceeded the historical median discharge, peaking at nearly ten times the historical median

(Figure 3). Based on the hydrograph, the April 9 sampling effort documented storm flow conditions in the watershed streams. Following storm events, the increased overland water flow results in increased erosion of soil and nutrients from the land. In addition, precipitation washes pollutants from hardscape in the watershed. Thus, stream concentrations of nutrients and sediment are typically higher following storm events. In essence, storm sampling presents a "worst case" picture of watershed pollutant loading.

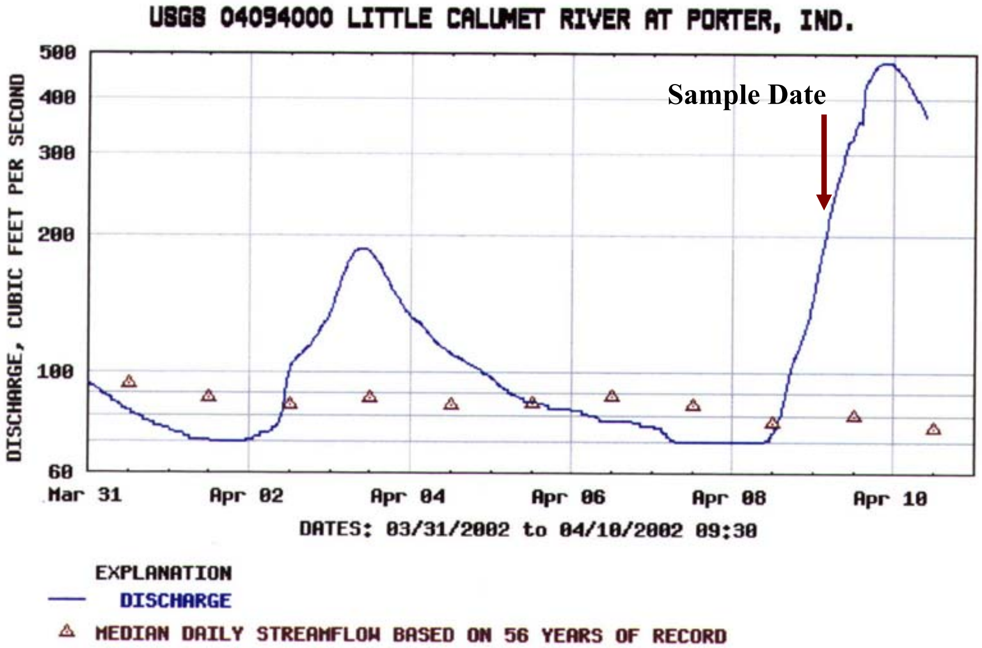

Figure 3. Mean daily discharge for the Little Calumet River at Porter, Indiana. The arrow marks the discharge on April 9, 2002. Discharge on the sampling date exceeded the 53-year median stream flow. Source: USGS, 2002.

The water quality samples were analyzed for a variety of physical, biological, and chemical parameters. The following is a brief description of each of these parameters.

Temperature

Temperature determines the form, solubility, and toxicity of a broad range of aqueous compounds. For example, water temperature affects the amount of oxygen dissolved in the water column. Cold water holds more oxygen than warm water. This is of particular importance in Coffee Creek since Coffee Creek harbors coldwater salmonid species. These fish require more oxygen, and thus colder water, than warmwater fish species. Water temperature also regulates the activity of life associated with the aquatic environment. Since essentially all aquatic organisms are 'cold-blooded' the temperature of the water regulates their metabolism and ability to survive and reproduce effectively (EPA, 1976). The Indiana Administrative Code (327 IAC 2-1-6) sets maximum temperature limits for Indiana streams. The IAC lists different limits for coldwater and warmwater streams. Although Coffee Creek is not classified as a coldwater stream in the IAC, the coldwater temperature limits may serve as a better guide for protecting Coffee Creek's biota. The IAC states that for coldwater streams "the maximum temperature rise above natural shall not exceed 1.1^{o} C at any time or place..." Additionally, temperatures in coldwater streams should not exceed 21.1° C at any time and shall not be above 18.3° C during spawning and imprinting periods.

Oxygen

Dissolved oxygen (DO) is the dissolved gaseous form of oxygen. It is essential for respiration of fish and other aquatic organisms. Fish need at least 3-5 parts per million (ppm) of DO. Coldwater fish such as trout generally require higher concentrations of DO than warmwater fish such as creek chub. The IAC sets minimum DO concentrations at 6 mg/L for coldwater fish. DO enters water by diffusion from the atmosphere and as a byproduct of photosynthesis by algae and plants. Excessive algae growth, accompanied by high levels of photosynthetic activity, can over-saturate (greater than 100% saturation) the water with DO. Dissolved oxygen is consumed by respiration of aquatic organisms, such as fish, and during bacterial decomposition of plant and animal matter.

pH

The pH of water describes the concentration of acidic ions (specifically H+) present in water. The pH also determines the form, solubility, and toxicity of a wide range of other aqueous compounds. The IAC establishes a range of 6 to 9 pH units for the protection of aquatic life. pH concentrations in excess of 9 are not considered acceptable when the concentration occurs as daily fluctuations associated with photosynthetic activity.

Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions and on their total concentration, mobility, and valence (APHA, 1995). At low discharge, conductivity of a stream is usually higher than it is following storm events because the water moves more slowly across or through ion-containing soils and substrates during base flow. Carbonates and other charged particles dissolve into the slow moving water, thereby increasing the conductivity of a water body.

Rather than setting a conductivity standard, the Indiana Administrative Code sets a standard for dissolved solids (750 mg/L). Multiplying a dissolved solids concentration by a conversion factor of 0.55 to 0.75 μmhos per mg/L of dissolved solids roughly converts a dissolved solids concentration to specific conductance (Allan, 1995). Thus converting the IAC dissolved solids concentration standard to specific conductance by multiplying 750 mg/L by 0.55 to 0.75 μmhos per mg/L yields a specific conductance range of approximately 1000 to 1360 μmhos. The Results and Discussion Section of this document presents conductivity measurements at each site in μmhos.

Nutrients (Nitrogen and Phosphorus)

Nutrients are a necessary component of aquatic ecosystems. Ecosystem primary producers (i.e. plants) require nutrients for growth. Growth of the primary producers ultimately supports the remainder of the organisms in the ecosystem's food web. Insufficient nutrient levels in stream and lake water can limit the size and complexity of biological communities living in the stream or lake. In contrast, excessive levels of nutrients in lake or stream water alter biological communities by promoting nuisance species growth. For example, high concentrations of total phosphorus in lake water (>0.03 mg/L) create ideal conditions for nuisance algae growth. In extreme cases, lake algae growth can exclude rooted macrophyte growth and shift fish community composition.

In low order streams such as Coffee Creek aquatic plants exist primarily as periphyton (algae attached to substrate or other surfaces in the stream). Light availability and flow regime limit the establishment of rooted macrophytes and phytoplankton populations that are more common in lakes and large river systems. As small stream ecosystems' primary producers, periphyton support higher members of the stream food web (invertebrates, fish). Nutrients are one of the factors that limit periphyton growth in streams and thus are included in stream water chemistry analyses.

Phosphorus and nitrogen are common nutrients governing plant growth. (When diatoms dominate the periphyton or planktonic community, silica is also an important nutrient.) Sources of phosphorus and nitrogen include fertilizers, human and animal waste, atmospheric deposition in rainwater, and yard waste or other plant material that reaches streams. Nitrogen can also diffuse from the air into streams. Atmospheric nitrogen is then "fixed" by certain algae species (cyanobacteria) into a usable form of nitrogen. Because of this readily available source of nitrogen (the air), phosphorus is usually the "limiting nutrient" in aquatic ecosystems.

Phosphorus and nitrogen exist in several forms in water. The two common phosphorus forms are soluble reactive phosphorus (SRP) and total phosphorus (TP). SRP is the dissolved form of phosphorus. It is the form that is "usable" by algae. Algae cannot directly digest and use particulate phosphorus for growth. Total phosphorus is a measure of both dissolved and particulate forms of phosphorus. The most commonly measured nitrogen forms are nitrate-nitrogen (NO_3), ammonia-nitrogen (NH_3), and total Kjeldahl nitrogen (TKN). Nitrate is a dissolved form of nitrogen that is commonly found in surface water where oxygen is readily available. In contrast, ammonia-nitrogen is generally found in water where oxygen is lacking. Ammonia-nitrogen, or more correctly the ionized form of ammonia-nitrogen (ammonium), is a dissolved form of nitrogen and the one utilized by algae for growth. Ammonia-nitrogen is also a byproduct of decomposition. The TKN measurement parallels the TP measurement to some extent. TKN is a measure of the total organic nitrogen (particulate) and ammonia-nitrogen in the water sample.

Indiana possesses nitrate-nitrogen and ammonia-nitrogen standards for its water bodies. These standards apply to all state water bodies except those designated as Limited Use waters. The nitrate-nitrogen standard is 10 mg/L; nitrate-nitrogen concentrations exceeding 10 mg/L in drinking water are considered hazardous to human health (Indiana Administrative Code IAC 2-1-6). Because both temperature and pH govern the toxicity of ammonia for aquatic life, these factors are weighed in setting the ammonia standard. According to the IAC, the maximum unionized ammonia concentration for the streams should is 0.044-0.178 mg/L depending upon the temperature and pH of the stream.

Total suspended solids

Total suspended solids refer to all particles suspended in stream water. Sediment, or dirt, is the most common solid suspended in stream water. The sediment in stream water originates from many sources, but a large portion of sediment entering streams comes from active construction sites or other disturbed areas such as unvegetated stream banks.

Suspended solids impact streams in a variety of ways. When suspended in the water column, solids can clog the gills of fish and invertebrates. As the sediment settles to the creek bottom, it covers spawning and resting habitat for aquatic fauna, reducing the animals' reproductive success. Suspended sediments also impair the aesthetic and recreational value of a waterbody. Few people are enthusiastic about having a picnic near a muddy creek or wading in silty water. Pollutants attached to sediment also degrade water quality.

Pathogens
Bacteria, viruses, and other pathogens are contaminants of concern in both rural and urban watersheds. Common sources of pathogens include human and wildlife waste, fertilizers containing manure, previously contaminated sediments, septic tank leachate, combined sewer overflows, and illicit connections to stormwater sewers or drainage tiles. Pathogenic organisms can threaten to human health by causing a variety of serious diseases, including infectious hepatitis, typhoid, gastroenteritis, and other gastrointestinal illnesses. Thus, pathogens can impair the recreational value of a stream. Some pathogens can also impair biological communities. Water quality researchers and monitoring programs utilize *E. coli* as an indicator for the presence of pathogens in water. According to the Indiana Administrative Code, *E. coli* concentrations should not exceed 235 colonies/100 mL in any one grab sample within a 30-day period.

Water Chemistry Results and Discussion
There are two useful ways to report water quality data in flowing water. *Concentrations* express the mass of a substance per unit volume, for example milligrams of total suspended solids per liter (mg/L). *Mass loading* describes the mass of a particular material being carried per unit time (kg/d). Loading is important when comparing among sites and among sampling dates because: 1) Flow can be highly variable; therefore, normalizing concentrations to flow eliminates this variability. 2) Delivery of materials is important to consider. A stream with high discharge but low pollutant concentration may deliver a larger portion of a pollutant to its receiving body than a stream with higher pollutant concentration but lower discharge. It is the total amount of nutrients, suspended solids, and pathogens entering the stream that is of greatest concern when considering the effects of these materials downstream.

Selected Physical and Chemical Parameter Concentrations
Table 2 presents selected physical and chemical parameter results measured during base flow and storm flow.

Table 2. Selected physical and chemical parameter data collected from the Coffee Creek watershed sites.

Site	Stream Name	Date	Flow (cfs)	Temperature (°C)	DO (mg/L)	% Saturation	pH	Conductivity (μmhos/cm)
1	Coffee Creek	27-Sep-01	13.30	11.9	9.6	88.9	8.7	6910
		14-Feb-02	28.40	1.2	12.9	90.6	7.9	700
		9-Apr-02	149.92	7.5	9.8	82.0	8.2	624
		29-Jul-02	5.31	22.2	7.3	83.8	7.6	700
2	Pope O'Connor Ditch	27-Sep-01	0.02	12.0	5.9	54.7	7.9	772
		14-Feb-02	3.90	0.3	10.6	73.2	7.7	1000
		9-Apr-02	32.70	6.5	8.5	68.5	7.2	782
		29-Jul-02	0.04	23.0	1.2	15.7	7.4	500
3	Coffee Creek	27-Sep-01	11.80	11.9	11.3	104.6	8.4	735
		14-Feb-02	22.10	1.3	13.2	93.4	8.3	600
		9-Apr-02	114.96	7.5	10.5	87.0	8.4	593
		29-Jul-02	4.50	23.0	7.7	89.0	7.6	600
4	Shooter Ditch	27-Sep-01	0.14	11.1	6.7	63.5	8.0	900
		14-Feb-02	1.50	2.7	11.7	86.2	8.1	800
		9-Apr-02	6.80	8.6	10.7	91.3	8.6	791
		29-Jul-02	0.00	24.0	4.0	50.5	7.6	700
5	Johnson Ditch	27-Sep-01	0.70	11.3	10.1	92.2	8.4	763
		14-Feb-02	2.60	2.2	13.9	101.6	8.3	600
		9-Apr-02	7.52	8.1	11.4	96.5	7.8	601
		29-Jul-02	0.25	22.4	7.5	86.7	7.7	700
6	Coffee Creek	27-Sep-01	5.40	11.2	9.7	88.4	8.3	702
		14-Feb-02	10.10	5.2	11.5	90.2	8.1	500
		9-Apr-02	37.36	9.4	10.9	94.9	7.8	551
		29-Jul-02	2.97	19.4	8.3	90.5	7.6	300
7	Suman Road Tributary	27-Sep-01	1.30	12.0	9.4	87.2	8.2	765
		14-Feb-02	1.50	9.2	9.5	82.2	8.6	700
		9-Apr-02	15.20	9.8	10.6	93.7	7.7	627
		29-Jul-02	1.49	14.9	8.7	86.0	6.9	500
8	Coffee Creek	27-Sep-01	0.50	12.0	8.3	77.0	8.0	756
		14-Feb-02	0.40	8.6	9.0	74.4	8.4	700
		9-Apr-02	0.97	10.2	8.5	76.0	7.2	615
		29-Jul-02	0.35	13.5	7.6	74.0	7.7	716

Water temperature varied with season. As expected Coffee Creek and its tributaries were warmer in September and July compared to February and April. In general, there was no consistent difference between water temperatures in the tributaries and the mainstem. Water temperatures varied little among sampling sites during the September 27 and April 9 sampling events. On September 27, Coffee Creek and its tributaries exhibited a water temperature range of 11.1-12.0 ^{o}C; on April 9 the temperature range was 6.5-10.2 ^{o}C. The creek's tributaries exhibited greater variability during the February sampling event (0.3-9.2 ^{o}C). Timing of sample collection may have influenced the observed variability. During the February collection, the lower numbered sites were sampled first (early AM) and the higher numbered sites were sampled last (afternoon). Sites located in the lower portion of the watershed exhibited slightly higher water temperatures compared to sites located in the upper watershed during the July 29 sampling event. (Again, sites were sampled in the same order as they are numbered. Thus, upper watershed sites were sampled in the afternoon.) The cooler water temperatures in the upper watershed may be the result of greater groundwater influence on the streams in the upper portion of the watershed compared to streams and sites in the lower portion of the watershed which received more water from surface inputs.

While none of the sites exhibited water temperatures above the warmwater standards set by the IAC for the protection of aquatic life, water temperatures at several sites during the July sampling event exceeded the IAC's coldwater standard. As noted previously, because Coffee Creek supports coldwater fish species, the IAC's coldwater standard may be a more appropriate guide to understanding what temperature levels protect Coffee Creek's biota. The July water temperatures recorded at all sites except the in Coffee Creek's headwaters (Site 8) and in Suman Road Tributary (Site 7) exceeded the IAC coldwater standard for spawning periods (18.3 ^{o}C). High water temperatures in Coffee Creek and its tributaries may stress coldwater fish species and limit their reproductive success; however, it is unlikely that any of the salmonid species were spawning or imprinting during July.

Dissolved oxygen concentrations in the Coffee Creek mainstem and creek tributaries varied from 1.2 mg/L (Pope O'Connor Ditch; July 29, 2002) to 13.2 mg/L (Johnson Ditch: February 14, 2002). DO in all streams exceeded the Indiana state minimum warmwater standard of 5 mg/L at all sites except Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4) in July indicating that oxygen was sufficient to support aquatic life during most of the hydrologic cycle. However, low DO levels in Pope O'Connor and Shooter Ditches limit the use of these ditches by fish as refuges. Dissolved oxygen concentrations in the mainstem sites (Sites 1, 3, 6, and 8) exceeded the coldwater temperature standards of 6 mg/L (absolute minimum) and 7 mg/L (minimum during spawning and imprinting periods). This suggests that dissolved oxygen concentrations in the mainstem are sufficient to support salmonid species.

Since DO varies with temperature (cold water can hold more oxygen than warm water), it is also important to examine DO saturation values. DO saturation refers to the amount of DO dissolved in water compared to the total amount possible when equilibrium between the stream water and the atmosphere is maximized. When a stream is less than 100% saturated with oxygen, decomposition processes within the stream may be consuming oxygen more quickly than it can be replaced and/or flow in the stream is not turbulent enough to entrain sufficient oxygen. Coffee Creek and two of its tributaries (Johnson Ditch and Suman Road Tributary) were 82-97% saturated with oxygen during sampling events. This range is typical of streams the size of Coffee Creek and its tributaries. In contrast, Pope O'Connor and Shooter Ditch exhibited low DO saturation during the September and July sampling events. The low percent saturation observed at these sites is likely due to the two factors noted above: the consumption of oxygen during the decomposition of organic material in the stream and relatively stagnant water limiting the entrainment of oxygen in the stream from the air. Coffee Creek at the Coffee Creek Center

(Site 3) exhibited supersaturated conditions during the September 29, 2002 sampling event. This supersaturated condition may be the result of photosynthetic activity at the site. This site also possesses the best riffle habitat of all the sampling sites. Oxygen entrainment occurs most readily in riffle habitat and thus may be the reason for the observed supersaturation at Site 3.

In general, both conductivity and pH values fell within acceptable ranges. Conductivity values in Coffee Creek watershed streams ranged from 300 to 6910 µmhos during base flow. The 6910 µmhos conductivity measurement recorded in Coffee Creek near its confluence with the Little Calumet River (Site 1) should be viewed as in outlier as all of the other measurements ranged from 300-1000 µmhos, a typical range for Indiana streams. Conductivity values in Coffee Creek watershed streams ranged from 551 to 786 µmhos during storm flow. All of these storm flow measurements fell below the lower end of the range obtained by converting the IAC dissolved solids standard to specific conductance. pH values in Coffee Creek and its tributaries ranged from 6.9 (Suman Road Tributary; July 29, 2002) to 8.7 (Coffee Creek near its confluence with the Little Calumet River; September 27, 2002). These pH values are within the range of 6-9 units established as acceptable by the Indiana Administrative Code for the protection of aquatic life.

Nutrient, Sediment, and Bacterial Parameter Concentrations
Table 3 lists the nutrient, sediment, and bacterial concentration data for Coffee Creek watershed streams by site.

Table 3. Nutrient, sediment, and bacterial parameter concentration data from the Coffee Creek watershed sites.

Site	Stream Name	Date	NO_3-N (mg/L)	NH_3-N (mg/L)	TKN (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
1	Coffee Creek	27-Sep-01	0.63	<0.01	0.69	<0.10	9.2	310
		14-Feb-02	0.43	0.01	<0.50	<0.10	4.8	70
		9-Apr-02	1.16	0.04	1.30	<0.10	61.0	1400
		29-Jul-02	0.18	0.04	<0.50	0.11	18.0	440
2	Pope O'Connor Ditch	27-Sep-01	0.33	0.09	1.20	<0.10	7.2	2400
		14-Feb-02	1.28	0.04	1.10	<0.10	2.0	220
		9-Apr-02	2.11	0.03	1.90	<0.10	18.0	320
		29-Jul-02	<0.05	0.17	1.80	0.51	15.0	1100
3	Coffee Creek	27-Sep-01	<0.05	<0.01	0.81	<0.10	2.4	210
		14-Feb-02	0.38	<0.01	0.66	<0.10	2.8	20
		9-Apr-02	1.15	0.07	1.50	<0.10	42.0	1600
		29-Jul-02	0.13	0.05	<0.50	<0.10	9.4	350
4	Shooter Ditch	27-Sep-01	0.71	0.30	1.40	<0.10	18.0	270
		14-Feb-02	0.79	0.13	1.30	<0.10	4.4	<10
		9-Apr-02	2.07	0.12	2.00	<0.10	16.0	100
		29-Jul-02	<0.05	0.13	1.40	0.21	88.0	190
5	Johnson Ditch	27-Sep-01	0.08	<0.01	0.58	<0.10	2.8	620
		14-Feb-02	0.21	<0.01	0.81	<0.10	<2.0	30
		9-Apr-02	1.08	0.02	1.20	<0.10	18.0	1600
		29-Jul-02	0.27	0.04	<0.50	0.26	18.0	1200
6	Coffee Creek	27-Sep-01	0.81	0.02	0.60	<0.10	6.8	10
		14-Feb-02	0.23	0.08	0.62	<0.10	6.0	30
		9-Apr-02	1.19	0.05	1.60	<0.10	52.0	200
		29-Jul-02	0.09	0.09	<0.50	<0.10	3.0	590
7	Suman Road Tributary	27-Sep-01	0.67	0.02	<0.50	0.72	5.2	20
		14-Feb-02	<0.05	0.10	0.58	<0.10	3.2	<10
		9-Apr-02	0.85	0.07	1.40	<0.10	88.0	80
		29-Jul-02	0.14	0.07	<0.50	0.11	6.6	1000
8	Coffee Creek	27-Sep-01	0.65	0.07	0.59	<0.10	8.4	310
		14-Feb-02	<0.05	0.20	<0.50	<0.10	8.0	20
		9-Apr-02	1.37	0.18	1.30	<0.10	25.0	40
		29-Jul-02	0.06	0.12	<0.50	<0.10	24.0	880

Nitrate-nitrogen concentrations during base and storm flow conditions were relatively low at most sites. Nitrate-nitrogen concentrations measured during the storm flow sampling event were greater than concentrations measured in base flow samples at all sites. Base flow concentrations ranged from below the detection limit (0.05 mg/L) in Pope O'Connor Ditch (Site 2; July 29, 2002), Shooter Ditch (Site 4; July 29, 2002), Suman Road Tributary (Site 7; February 14, 2002), and the Coffee Creek headwaters (Site 8; February 14, 2002) to 1.28 mg/L at Pope O'Connor

Ditch (Site 2; February 14, 2002), while storm flow nitrate-nitrogen concentrations ranged from 0.85 mg/L in the Suman Road Tributary (Site 7) to 2.1 mg/L in Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4). Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4) exhibited the highest nitrate-nitrogen concentrations. Nitrate-nitrogen concentrations observed during base flow conditions were generally lower than median nutrient concentrations observed in Ohio streams (1.0 mg/L) known to support healthy warmwater fauna (Ohio EPA, 1999). Additionally, all sites, except Pope O'Connor Ditch and Shooter Ditch during storm flow, met the USEPA recommended criteria for nitrate-nitrogen of 1.798 mg/L for streams in the Central Corn Belt Plain (USEPA, 2000). Concentrations at all sites were below 10 mg/L, the concentration set by the Indiana Administrative Code for safe drinking water.

Ammonia-nitrogen concentrations were higher than the nitrate-nitrogen concentrations at most sites during base and storm flow sampling events. Under base flow conditions, Shooter Ditch (Site 4) exhibited the highest ammonia-nitrogen concentration (0.3 mg/L), while the Coffee Creek mainstem sites near its confluence with the Little Calumet River (Site 1) and in the Coffee Creek Center (Site 3) and Johnson Ditch (Site 5) base flow samples possessed the lowest ammonia-nitrogen concentration (<0.01 mg/L). Generally, Pope O'Connor Ditch (Site 2), Shooter Ditch (Site 4), and the Coffee Creek headwaters (Site 8) had the highest ammonia-nitrogen concentrations. The high ammonia-nitrogen concentrations coupled with low levels of dissolved oxygen in Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4) suggest decomposition is occurring at these sites. Three of the four samples collected in Shooter Ditch (Site 4) and in the Coffee Creek headwaters (Site 8) exceeded the IAC ammonia-nitrogen standard for the protection of aquatic life. Ammonia-nitrogen concentrations in Pope O'Connor (Site 2) and the Suman Road Tributary (Site 7) collected during the July 29, 2002 sampling event also exceeded the IAC ammonia-nitrogen standard for the protection of aquatic life. The high ammonia-nitrogen levels at these sites may be impairing the tributaries' aquatic life.

Many of the sites' exhibited elevated total Kjeldahl nitrogen (TKN) concentrations. TKN concentrations measured during storm flow sampling exceeded the concentrations measured during base flow sampling. As observed with the ammonia-nitrogen concentrations, Shooter Ditch (Site 4) and Pope O'Connor Ditch (Site 2) exhibited higher concentrations of TKN compared to the other tributaries and Coffee Creek's mainstem. At least one sample collection from the Coffee Creek mainstem sites (Sites 1, 3, 6, and 8), Johnson Ditch (Site 4), and the Suman Road Tributary (Site 7) possessed TKN concentrations below the laboratory detection limit of 0.5 mg/L. In contrast, all of the samples collection from Shooter Ditch (Site 4) and Pope O'Connor Ditch (Site 2) possessed TKN concentrations above 1.1 mg/L. Although ammonia-nitrogen concentrations were also elevated at these sites, particulate organic nitrogen pollutants are likely at these sites as well. High TKN levels were not surprising at these sites given the observed accumulation of organic matter at these locations.

Under both base and storm flow conditions, total phosphorus concentrations were generally low in the Coffee Creek mainstem and its tributaries. Eighteen of the twenty-four samples exhibited total phosphorus concentrations below the laboratory detection limit of 0.1 mg/L. Five of the exceedences occurred during the July base flow sampling event. Only the Suman Road Tributary (Site 7) possessed total phosphorus concentrations greater than the detection limit during more than one sampling event. The highest concentrations of total phosphorus were observed in Pope O'Connor Ditch (Site 2; 0.51 mg/L on July 29, 2002), Shooter Ditch (Site 4; 0.21 mg/L on July

29, 2002), and Johnson Ditch (Site 5: 0.26 mg/L on July 29, 2002). These total phosphorus concentrations exceed the Ohio EPA's numeric total phosphorus criteria set to protect aquatic life. (Indiana does not have numeric nutrient criteria.) Additionally, these levels exceed the level found by Dodd et al. (1998) to mark the boundary between mesotrophic and eutrophic stream conditions, suggesting these systems are eutrophic. The high total phosphorus concentrations and resultant productivity in these tributaries may be altering the tributaries' biotic community structure and impairing aquatic life in the tributaries. These pollutant levels may also prevent the use of these tributaries by mainstem biota as refuges.

Total suspended solids concentrations measured during storm flow sampling exceeded concentrations measured in base flow samples at all sample sites except Shooter Ditch (Site 4). Higher overland flow velocities typically result in an increase in sediment particles in runoff. Additionally, greater streambank and stream bed erosion occurs during high flow. Therefore, higher concentrations of suspended solids are typically measured in storm flow samples. The storm flow sample collected in the Suman Road Tributary (Site 7) and in Shooter Ditch (Site 4) during base flow exhibited the highest total suspended solids concentration (88 mg/L). These TSS concentrations exceed the concentration found to be deleterious to aquatic life (Waters, 1995).

Figures 4 and 5 display the *E. coli* concentration data for the four sampling events. As expected, the *E. coli* concentrations observed during the February base flow sampling event were low. High *E. coli* concentrations were not likely given the low water temperature. At each site, *E. coli* concentrations measured during the other two base flow sampling events (September and July) and during the storm flow sampling event exceeded the Indiana state standard (235 col/100 mL) for state waters at least once. Under base flow conditions, the Coffee Creek tributaries generally possessed higher concentrations of *E. coli* compared to the mainstem. Base flow concentrations of *E. coli* were of particular concern in Pope O'Connor Ditch (Site 2) where concentrations in July and September were approximately 5 and 10 times the state standard, respectively. High *E. coli* concentrations suggest the presence of other pathogens. These pathogens may impair the tributaries biota and limit human use of the creeks.

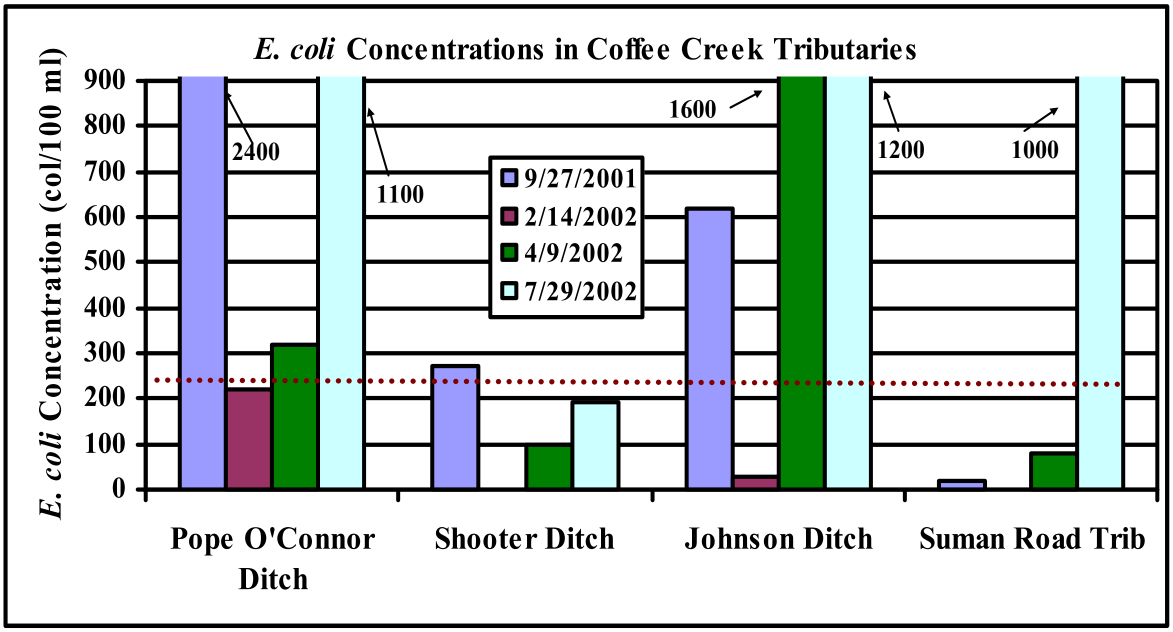

Figure 4. *E. coli* concentrations measured in Coffee Creek tributaries. The dashed line marks the Indiana state *E. coli* standard (235 col/100 mL).

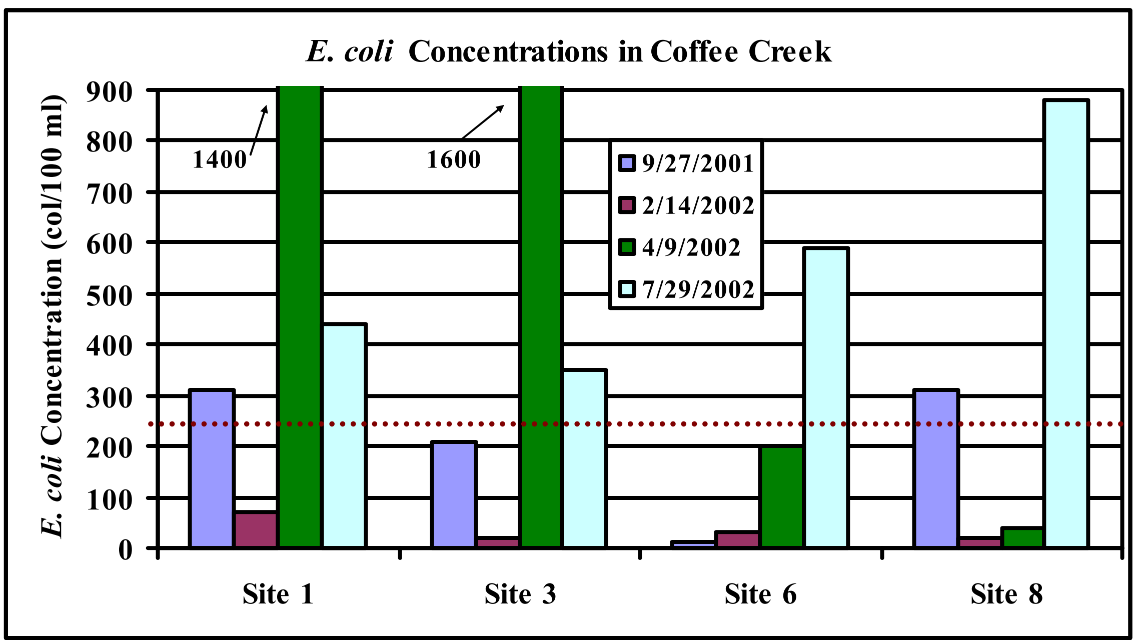

Figure 5. *E. coli* concentrations measured in Coffee Creek mainstem. The dashed line marks the Indiana state *E. coli* standard (235 col/100 mL).

Nutrient and Sediment Parameter Loading

Table 4 lists the nutrient and sediment mass loading data for Coffee Creek watershed by site.

Table 4. Chemical and bacterial parameter loading data collected in the Coffee Creek watershed streams.

Site	Stream Name	Date	NH_3-N Load (kg/d)	NO_3-N Load (kg/d)	TKN Load (kg/d)	TP Load (kg/d)	TSS Load (kg/d)
1	Coffee Creek	27-Sep-01	bdl	20.49	22.44	bdl	299.18
		14-Feb-02	0.69	29.86	bdl	bdl	333.32
		9-Apr-02	14.66	425.22	476.54	bdl	22360.92
		29-Jul-02	0.52	2.34	6.49	1.43	233.53
2	Pope O'Connor Ditch	27-Sep-01	0.00	0.02	0.06	bdl	0.35
		14-Feb-02	0.38	12.21	10.49	bdl	19.07
		9-Apr-02	2.40	168.71	151.92	bdl	1439.20
		29-Jul-02	0.02	0.00	0.16	0.05	1.36
3	Coffee Creek	27-Sep-01	bdl	bdl	23.37	bdl	69.25
		14-Feb-02	bdl	20.53	35.66	bdl	151.30
		9-Apr-02	19.68	323.25	421.64	bdl	11805.82
		29-Jul-02	0.55	1.43	5.50	bdl	103.43
4	Shooter Ditch	27-Sep-01	0.10	0.24	0.48	bdl	6.16
		14-Feb-02	0.48	2.90	4.77	bdl	16.14
		9-Apr-02	2.00	34.42	33.25	bdl	266.03
		29-Jul-02	--	--	--	--	--
5	Johnson Ditch	27-Sep-01	bdl	0.14	0.99	bdl	4.79
		14-Feb-02	bdl	1.34	5.15	bdl	bdl
		9-Apr-02	0.37	19.85	22.05	bdl	330.75
		29-Jul-02	0.02	0.16	0.30	0.16	10.87
6	Coffee Creek	27-Sep-01	0.26	10.69	7.92	bdl	89.78
		14-Feb-02	1.98	5.68	15.31	bdl	148.17
		9-Apr-02	4.57	108.71	146.16	bdl	4750.18
		29-Jul-02	0.65	0.65	3.63	bdl	21.76
7	Suman Road Tributary	27-Sep-01	0.06	2.13	bdl	2.29	16.53
		14-Feb-02	0.37	bdl	2.13	bdl	11.74
		9-Apr-02	2.60	31.59	52.03	bdl	3270.59
		29-Jul-02	0.26	0.51	1.82	0.40	24.05
8	Coffee Creek	27-Sep-01	0.09	0.79	0.72	bdl	10.27
		14-Feb-02	0.20	bdl	bdl	bdl	7.82
		9-Apr-02	0.43	3.25	3.08	bdl	59.29
		29-Jul-02	0.10	0.05	0.42	bdl	20.36

Note: A double dash (--) indicates that water was not flowing at the time of collection, while the abbreviation bdl indicates that concentrations were below the laboratory detection level. In both cases, loads could not be calculated.

In general, the highest pollutant loading rates were observed at the Coffee Creek mainstem site near the creek's confluence with the Little Calumet River (Site 1). Under base flow conditions, this site possessed the greatest loading rate for nitrate-nitrogen and total suspended solids. Under storm flow conditions, the site possessed the highest loading rate for nitrate-nitrogen, total suspended solids, and total Kjeldahl nitrogen. This is to be expected. As the site located furthest downstream, this site receives the pollutants from all the other sites.

Some stream systems can process or assimilate pollutants rather than transporting them downstream. The drop in ammonia-nitrogen loading rate between the Coffee Creek mainstem site at Mander Road (Site 6) and the mainstem site in the Coffee Creek Center (Site 3) may be due to the conversion of ammonia to nitrate. Ammonia readily oxidizes to nitrate in the presence of oxygen. The riffle habitat at Site 3 provides an excellent opportunity for oxygen to diffuse into the water column. The decrease in the TKN loading rate observed between the Coffee Creek mainstem site in the Coffee Creek Center (Site 3) and Coffee Creek near its confluence with the Little Calumet River (Site 1) suggests that some deposition of particulate nutrients occurs between these sites. This deposition may occur within the stream bed and therefore may be temporary in nature. Alternatively, the deposition may be more permanent if it occurs in the creek's floodplain. Given the lack of riparian floodplain between Sites 1 and 3, it is more likely that the deposition is occurring within the stream channel itself.

Of the four major tributaries to Coffee Creek, Pope O'Connor Ditch and the Suman Road Tributary delivered the greatest pollutant loads to the Coffee Creek mainstem. Under base and storm flow conditions, Pope O'Connor Ditch delivered more nitrate-nitrogen and total Kjeldahl nitrogen than the other tributaries to Coffee Creek. The Suman Road Tributary carried more suspended solids to Coffee creek under both base and storm flow conditions. Pope O'Connor Ditch and the Suman Road Tributary delivered comparable loads of ammonia-nitrogen to the mainstem under storm flow conditions, while Shooter Ditch contributed more ammonia-nitrogen under base flow conditions. It is important to note that the Pope O'Connor Ditch sampling site was not near or at its confluence with Coffee Creek, while the sampling points on the other tributaries are close to their confluences with Coffee Creek. (The Pope O'Connor Ditch sampling site location was based on accessibility.) Thus, the loading rate reported for Pope O'Connor Ditch in Table 4 may underestimate the total amount of pollutants delivered to the Coffee Creek mainstem. The modeling conducting as a part of this project (Appendix G) may provide a better estimate of the relative contributions of each tributary.

<u>Macroinvertebrate Community Assessment</u>

Macroinvertebrate Methods

The benthic macroinvertebrate community in Coffee Creek and its major tributaries was surveyed twice during the study period: once on June 30, 2002 and a second time on October 21, 2002. Macroinvertebrates were collected from eight sites located throughout the watershed (Table 1; Figure 1) using methodologies outlined in the Coffee Creek Watershed Quality Assurance Project Plan (Appendix F). The specifics of these methodologies will not be repeated here. The collection methods were altered slightly to improve collection of macroinvertebrates in Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4). The soft, mucky substrate in these ditches prohibited the use of a kick net. Instead, a D-frame dip net was swept through the rooted macrophyte community at these sites. In addition, woody debris, if present, was washed to collect any invertebrates inhabiting the woody substrate.

The benthic community at each sample site was evaluated using two biological indices: the Hilsenhoff Family Level Biotic Index (FBI) (Hilsenhoff, 1988) and IDEM's macroinvertebrate

Index of Biotic Integrity (mIBI) (IDEM, unpublished). The FBI uses the macroinvertebrate community to assess the level of organic pollution in a stream. The FBI is based on the premise that different families of aquatic insects possess different tolerance levels to organic pollution. Hilsenhoff assigned each aquatic insect family a tolerance value from 1 to 9; those families with lower tolerances to organic pollution were assigned lower values, while families that were more tolerant to organic pollution were assigned higher values. The FBI is calculated by multiplying the number of organisms from each family collected at a given site by the family tolerance value, summing these products, and dividing by the total number of organisms in the sample:

$$FBI = \frac{\sum x_i t_i}{n}$$

where x_i is the number of species in a given family, t_i is the tolerance values of that family, and n is the total number of organisms in the sample. Benthic communities dominated by organisms that are tolerant of organic pollution will exhibit higher FBI scores compared to benthic communities dominated by intolerant organisms.

IDEM's mIBI is a multi-metric index designed to provide a complete assessment of a creek's biological integrity. Karr and Dudley (1981) define biological integrity as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the best natural habitats within a region". It is likely that this definition of biological integrity is what IDEM means by biological integrity as well. The mIBI consists of ten metrics (Table 5) which measure the species richness, evenness, composition, and density of the benthic community at a given site. The metrics include family-level HBI (Hilsenhoff's FBI), number of taxa, number of individuals, percent dominant taxa, EPT Index, EPT count, EPT count to total number of individuals, EPT count to chironomid count, chironomid count, and total number of individuals to number of squares sorted. (EPT stands for the Ephemeroptera, Plecoptera, and Trichoptera orders.) A classification score of 0, 2, 4, 6, or 8 is assigned to specific ranges for metric values. For example, if the benthic community being assessed supports nine different families, that community would receive a classification score of 2 for the "Number of Taxa" metric. The mIBI is calculated by averaging the classification scores for the ten metrics. mIBI scores of 0-2 indicate the sampling site is severely impaired; scores of 2-4 indicate the site is moderately impaired; scores of 4-6 indicate the site is slightly impaired; and scores of 6-8 indicate that the site is non-impaired.

Table 5. Benthic macroinvertebrate scoring criteria used by IDEM in the evaluation of pool-riffle streams in Indiana.

	SCORING CRITERIA FOR THE FAMILY LEVEL MACROINVERTEBRATE INDEX OF BIOTIC INTEGRITY (mIBI) USING PENTASECTION AND CENTRAL TENDENCY ON THE LOGARITHMIC TRANSFORMED DATA DISTRIBUTIONS OF THE 1990-1995 RIFFLE KICK SAMPLES				
	CLASSIFICATION SCORE				
	0	2	4	6	8
Family Level HBI	≥5.63	5.62- 5.06	5.05-4.55	4.54-4.09	≤4.08
Number of taxa	≤7	8-10	11-14	15-17	≥18
Number of individuals	≤79	129-80	212-130	349-213	≥350
Percent dominant taxa	≥61.6	61.5-43.9	43.8-31.2	31.1-22.2	<22.1
EPT index	≤2	3	4-5	6-7	≥8
EPT count	≤19	20-42	43-91	92-194	≥195
EPT count to total number of individuals	≤0.13	0.14-0.29	0.30-0.46	0.47-0.68	≥0.69
EPT count to chironomid count	≤0.88	0.89-2.55	2.56-5.70	5.71-11.65	≥11.66
Chironomid count	≥147	146-55	54-20	19-7	≤6
Total number of individuals to number of squares sorted	≤29	30-71	72-171	172-409	≥410

Where: 0-2 = Severely Impaired, 2-4 = Moderately Impaired, 4-6 = Slightly Impaired, 6-8 = Non-impaired

IDEM developed the classification criteria based on five years of wadeable riffle-pool data collected in Indiana. Because the values for some of the metrics can vary depending upon the collection and subsampling methodologies used to survey a stream, it is important to adhere to the collection and subsampling protocol IDEM used when it developed the mIBI. As noted above, the lack of suitable habitat and substrate in Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4) prohibited the use of the IDEM mIBI sampling protocol. Consequently, when the mIBI scores were calculated for these sites, the protocol dependent metrics (number of taxa, number of individuals, EPT Index, EPT Count, and chironomid count) were not included in the metric classification score averaging. Eliminating the protocol dependent metrics allows the mIBI scores at sites surveyed using different survey protocols to be compared to mIBI scores at sites sampled using the IDEM recommended protocol (Steve Newhouse, IDEM Biological Surveys Section, email correspondence).

Macroinvertebrate Results and Discussion

Tables 6 and 7 present the results of the macroinvertebrate surveys. In general, the Coffee Creek mainstem sites (Sites 1, 3, and 6) supported more diverse and more pollution intolerant communities than the Coffee Creek headwaters (Site 8) and the Coffee Creek tributaries (Sites 2, 4, 5, and 7). Taxa richness (number of taxa) was similar among the Coffee Creek mainstem sites (Sites 1, 3, and 6), Pope O'Connor Ditch (Site 2), and Shooter Ditch (Site 4) during the spring survey. In the spring, Johnson Ditch (Site 5) and the Suman Tributary (Site 7) supported fewer taxa compared to other sites. During the fall survey, Coffee Creek near its confluence with the Little Calumet (Site 1), Johnson Ditch (Site 5), and Coffee Creek near Mander Road supported the greatest number of taxa, while Shooter Ditch (Site 4) and the Coffee Creek headwaters (Site 8) exhibited the lowest taxa richness. Coffee Creek mainstem sites (Sites 1, 3, and 6) supported more sensitive taxa. These sites possessed greater EPT index scores and more individuals from these sensitive orders compared to the other sites. During the fall survey, members of the EPT taxa dominated the benthic community at Coffee Creek mainstem site in the Coffee Creek Center (Site 3), accounting for nearly 80% of the total subsample. Additionally, Coffee Creek mainstem sites (Sites 1, 3, and 6) were the only ones to harbor members of the Plecopteran order, which is arguably the most sensitive order. Members of the Plecopteran order are extremely intolerant to sediment and organic pollution.

When the macroinvertebrate communities at each sampling site are evaluated using the FBI, the FBI scores reflect the relative differences in macroinvertebrate community composition noted above (Tables 8 and 9). The Coffee Creek mainstem Sites 1, 3, and 6 along with the Suman Tributary (Site 7) had lower (better) FBI scores compared to Pope O'Connor Ditch (Site 2), Shooter Ditch (Site 4), and Johnson Ditch (Site 5). Spring FBI scores in the mainstem suggest Coffee Creek possessed good to very good water quality and organic pollution level was slight to moderate. In contrast, the spring FBI scores indicate that water quality was fairly poor in Johnson Ditch and very poor in Pope O'Connor and Shooter Ditches. The FBI scores also suggest that the level of organic pollution in these tributaries to Coffee Creek ranged from substantial to severe. Fall FBI scores again indicated that Coffee Creek mainstem Sites 3 and 6 and the Suman Tributary possessed good to excellent water quality and organic pollution was minimal to moderate. The Fall FBI score at Shooter Ditch (Site 4) suggested continued severe impairment due to organic pollution. The Fall FBI scores suggest water quality declined slightly near Coffee Creek's confluence with the Little Calumet River (Site 1) and improved slightly in Johnson Ditch (Site 5). Both sampling sites fell in the middle range of the FBI (fair to fairly poor water quality with fairly substantial to substantial levels of organic pollution.

Table 6. Macroinvertebrate families collected by site during the spring sample collection conducted June 30, 2002. Samples were not collected at Site 8 due to the inability to access the site.

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Ephemeroptera								
Heptageniidae	4		5					
Oligoneuriidae								
Odonata								
Calopterygidae					1			
Coenagrioniidae				3				
Lestidae		2						
Plecoptera								
Perlidae	6		9			4		
Hemiptera								
Corixidae				2				
Trichoptera								
Hydropsychidae	1		36			6		
Lepidostomatidae						3	1	
Limnephilidae				1				
Coleoptera								
Dytiscidae		1						
Haliplidae	1	1						
Diptera								
Chironomidae (all other)	4	1	10	7	2	1	2	
Chironomidae (blood red)	5							
Empididae			1					
Simulidae							2	
Tabanidae						1		
Tipulidae						1		
Arthropoda								
Asellidae	15	146	17	107	5	10	5	
Asticidae	51							
Cambaridae			1					
Gammaridae			23		5	73	100	
Talitridae		1		112				
Gastropoda								
Lymnaea		1						
Physa		14		7				
Planorbidae				9				
Pelecypoda								
Spaeriidae			1					
Platyhelminthes								
Nematoda	1				63			
TOTALS								
Individuals	**88**	**167**	**103**	**248**	**76**	**99**	**110**	**0**
Number of Taxa	**8**	**8**	**9**	**8**	**5**	**8**	**5**	**0**

Table 7. Macroinvertebrate families collected by site during the fall sample collection conducted October 21, 2002. Samples were not collected at Site 2 due to the absence of flowing water.

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Ephemeroptera								
Baetidae	4				3	4	25	
Heptageniidae	3		13		1	23		
Oligoneuriidae			30					
Odonata								
Calopterygidae	1				1			
Coenagrioniidae				21				
Plecoptera								
Ptychopteridae						1		
Hemiptera								
Corixidae						1		
Trichoptera								
Hydropsychidae	4		58		10	3	9	
Limnephilidae							5	
Philopotamidae			12					
Coleoptera								
Elmidae			13	1	4			
Haliplidae								
Psychomyiidae	1							
Diptera								
Ceratopogonidae						1		
Chironomidae (all other)	16		6		14	1	1	
Chironomidae (blood red)	1							
Ephydridae					1			
Simulidae	22		8		1	6		
Tabanidae	1				1	2		
Tipulidae	4		2		1	2	8	12
Arthropoda								
Asellidae	5			26	12	3	6	15
Gammaridae	6				22	61	129	52
Talitridae				57				
Gastropoda								
Physa						1		
Planorbidae					1			
Platyhelminthes								
Turbellaria				11	1			
Annelida								
Oligochaeta	13				2	1		
TOTALS								
Individuals	**81**	**0**	**142**	**116**	**75**	**110**	**183**	**79**
Number of Taxa	**12**	**0**	**8**	**5**	**15**	**14**	**7**	**3**

Table 8. Family-level Hilsenhoff Biotic Index at eight survey sites for spring and fall samples. Sample collection did not occur at Site 8 in the spring or Site 2 in the fall.

Site	Spring HBI	Fall HBI
Site 1-Coffee Creek at near Little Calumet Riv. confluence	4.81	5.42
Site 2-Pope O'Connor Ditch	7.98	--
Site 3-Coffee Creek at Coffee Creek Center Development	4.65	3.6
Site 4-Shooter Ditch	7.93	7.76
Site 5-Johnson Ditch	5.92	5.13
Site 6-Coffee Creek at Mander Road	4.22	4.27
Site 7-Suman Road Tributary	4.22	4.09
Site 8-Coffee Creek Headwaters	--	4.60

Table 9. Water quality correlation to Hilsenhoff Biotic Index score.

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.00	Very poor	Severe organic pollution likely

The FBI scores are consistent with the results of the water chemistry sampling effort. Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4) exhibited the highest (worst) FBI scores from both the Spring and Fall macroinvertebrate sampling efforts suggesting high levels of organic pollution in these ditches. Both Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4) also possessed the highest concentrations of total Kjeldahl nitrogen. (Total Kjeldahl nitrogen is a measure of the amount of ammonia and organic nitrogen (particulate) in the water column.) These ditches also exhibited high total phosphorus (particulate phosphorus) relative to the other sites. This evidence suggests the organic matter in these ditches is impairing their biological integrity. Organic matter accumulation was also observed during site inspections at these locations.

The mIBI scores highlight the difference between the macroinvertebrate communities found in the mainstem of Coffee Creek (Sites 1, 3, and 6) and its tributaries even further. (Attachment 1 provides mIBI metric scores and calculations.) In general, the biotic integrity of the macroinvertebrate communities in the mainstem of Coffee Creek is less impaired than it is in the Coffee Creek tributaries. The results of the Spring survey clearly demonstrate this difference (Table 10). Coffee Creek mainstem (Sites 1, 3, and 6) mIBI scores suggest the macroinvertebrate communities in Coffee Creek are moderately impaired, while tributary mIBI scores indicate the macroinvertebrate communities in the Coffee Creek tributaries are severely impaired (Table 5). Most indices of biotic integrity are developed to ensure that there is a statistically significant difference between impairment categories (Karr and Chu, 1999). As such, the Spring 2002 macroinvertebrate survey results suggest there is a significant difference between the biological integrity of the macroinvertebrate communities in Coffee Creek and the macroinvertebrate communities in its tributaries.

Table 10. Classification scores and mIBI score for each sampling site within the Coffee Creek watershed as sampled June 30, 2002.

	Coffee Creek (1)	Pope O'Connor Ditch (2)	Coffee Creek (3)	Shooter Ditch (4)	Johnson Ditch (5)	Coffee Creek (6)	Suman Road Trib. (7)	Coffee Creek (8)
HBI	4	0	4	0	0	6	6	--
No. of Taxa (family)	2	--	2	--	0	2	0	--
Number of Individuals	2	--	2	--	2	2	2	
% Dominant Taxa	2	0	4	2	0	0	0	--
EPT Index	2	--	2	--	0	2	0	--
EPT Count	0	--	4	--	0	0	0	--
EPT Count/Total Count	0	0	6	0	0	0	0	--
EPT Abun./Chir. Abun.	2	0	4	0	0	8	0	--
Chironomid Count	6	--	6	--	8	8	8	--
No. Individuals/Square	0	2	0	4	--	0	0	--
mIBI Score	**2.00**	**0.40**	**3.40**	**1.20**	**1.11**	**2.80**	**1.60**	**--**

When evaluated using the mIBI, the results of the Fall 2002 macroinvertebrate survey are less clear (Table 11). mIBI scores again suggest that the biological integrity of the macroinvertebrate communities in the Coffee Creek mainstem Sites 1 and 6 is moderately impaired. Fall mIBI scores in Johnson Ditch (Site 5) and the Suman Tributary (Site 7) improved over the spring mIBI scores. The fall scores for these tributaries suggest the biological integrity of their macroinvertebrate communities is only moderately impaired. Based on the fall mIBI score, the biological integrity of their macroinvertebrate community at Coffee Creek within the Coffee Creek Center (Site 3) is only slightly impaired. Fall mIBI scores confirm the poor biological integrity of the macroinvertebrate community in Shooter Ditch.

Table 11. Classification scores and mIBI score for each sampling site within the Coffee Creek watershed as sampled October 21, 2002.

	Coffee Creek (1)	Pope O'Conner Ditch (2)	Coffee Creek (3)	Shooter Ditch (4)	Johnson Ditch (5)	Coffee Creek (6)	Suman Road Trib. (7)	Coffee Creek (8)
HBI	2	--	8	0	2	6	6	4
No. of Taxa (family)	4	--	2	--	6	4	0	0
Number of Individuals	2	--	4	--	0	2	4	0
% Dominant Taxa	6	--	4	2	6	4	0	0
EPT Index	2	--	4	--	2	2	2	0
EPT Count	0	--	6	--	0	4	2	0
EPT Count/Total Count	2	--	8	0	2	2	2	0
EPT Abun./Chir. Abun.	0	--	8	0	2	8	8	0
Chironomid Count	6	--	8	--	6	8	8	0
No. Individuals/Square	0	--	0	0	0	0	2	0
mIBI Score	**2.40**	--	**5.20**	**0.40**	**2.60**	**4.00**	**3.40**	**0.40**

The mIBI scores support the hypothesis that poor water quality in the coffee Creek tributaries may be impairing these streams' biological integrity. High nutrient concentrations, high total suspended solid concentrations, and low dissolved oxygen levels were recorded in Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4), particularly during the July 29, 2002 sampling. These same waterbodies exhibited mIBI scores that indicate severe biotic integrity impairment. These results are consistent with results observed in Ohio (Ohio EPA, 1999) and throughout the U.S. (Dodd et al., 2000).

Although these criteria are not part of the Indiana Administrative Code, IDEM hints that it may be using mIBI scores to determine whether a waterbody is meeting its aquatic life use designation. (Under state law, all waters of the state, except for those noted as Limited Use in the Indiana Administrative Code, must be capable of supporting recreational and aquatic life uses.) In the 2000 305 (b) report, IDEM suggests that those waterbodies with mIBI scores less than 2 are considered non-supporting for aquatic life use. Similarly, waterbodies with mIBI scores between 2 and 4 are considered to be partially supporting for aquatic life use. Under federal law, waters that do not meet their designated uses must be placed on the 303 (d) list and remediation/restoration plans (Total Maximum Daily Load plans) must be developed for these waters.

Figures 6 and 7 show the Coffee Creek watershed mIBI scores based on the spring and fall sampling efforts with to respect the suggested IDEM criteria. mIBI scores at Coffee Creek mainstem sites, excluding the headwaters site, indicate that the creek is at least partially supporting of aquatic life use. At the Coffee Creek mainstem site within the Coffee Creek Center (Site 3), the mIBI score suggests this portion of the creek may be fully support aquatic life. In contrast, mIBI scores at Pope O'Connor Ditch (Site 2), Shooter Ditch (Site 4), and in the Coffee Creek headwaters (Site 8) indicate these waters do not support the designated aquatic life use.

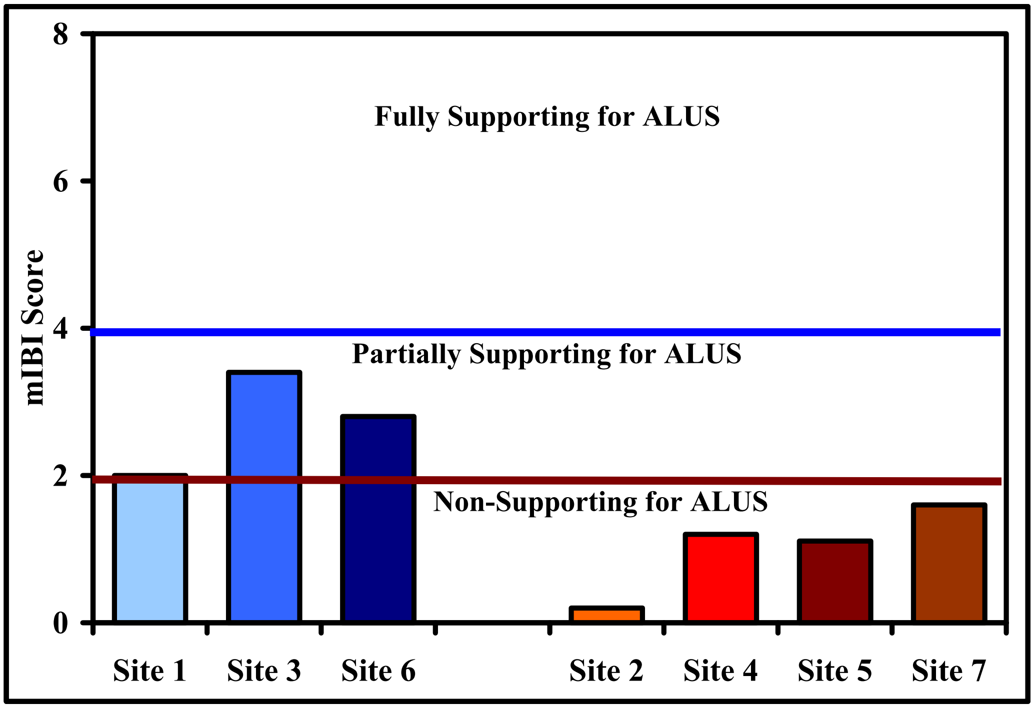

Figure 6. Aquatic life use support assessment based on spring macroinvertebrate community collection.

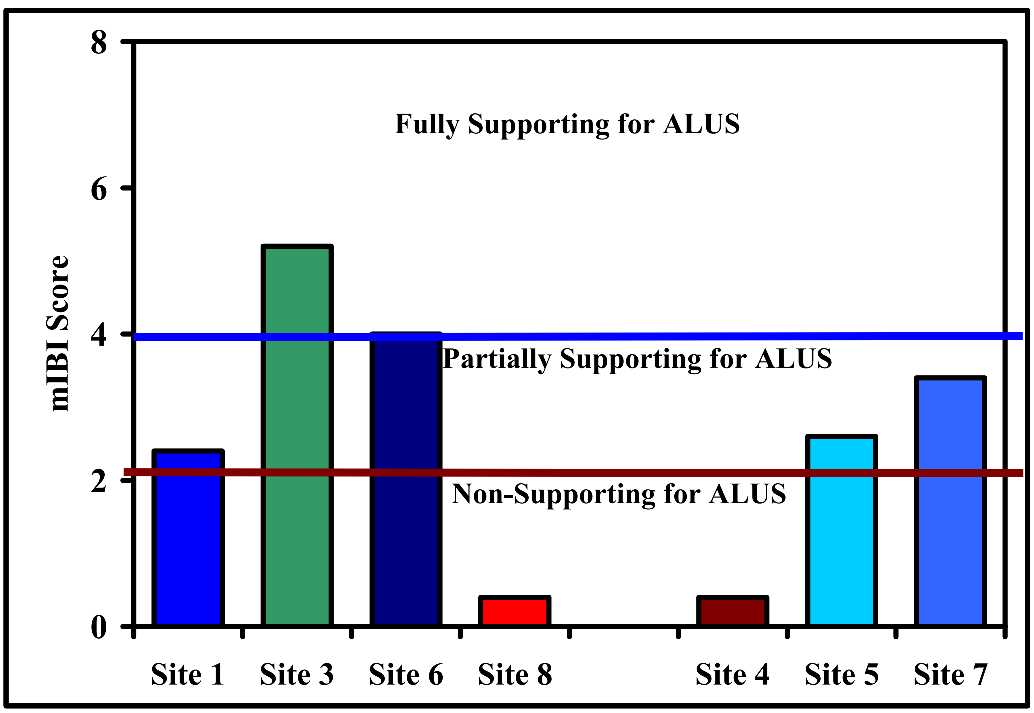

Figure 7. Aquatic life use support assessment based on fall macroinvertebrate community collection.

Habitat Assessment

Habitat Methods

The in-stream and riparian habitat of Coffee Creek and its major tributaries was evaluated once during the study period. Habitat was evaluated using at each of the eight sampling sites (Table 1; Figure 1) using the Qualitative Habitat Evaluation Index (QHEI). The Ohio Environmental Protection Agency (Ohio EPA) developed the QHEI for streams and rivers in Ohio (Rankin 1989, 1995). The QHEI is a physical habitat index designed to provide an empirical, quantified evaluation of the general lotic macrohabitat (Ohio EPA, 1989). While the Ohio EPA originally developed the QHEI to evaluate fish habitat in streams, IDEM and other agencies routinely utilize the QHEI as a measure of general "habitat" health. The QHEI is composed of six metrics including substrate composition, in-stream cover, channel morphology, riparian zone and bank erosion, pool/glide and riffle-run quality, and map gradient. Each metric is scored individually then summed to provide the total QHEI score. The best possible score is 100. Specifics regarding the QHEI protocol and metrics are included in the Coffee Creek Watershed Quality Assurance Project Plan (Appendix F) and will not be repeated here.

The QHEI evaluates the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of stream segments in Ohio have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas. Scores greater than 75 typify habitat conditions that have the ability to support exceptional warmwater faunas (Ohio EPA, 1999). IDEM indicates that QHEI scores above 64 suggest the habitat is capable of supporting a balanced warmwater community; scores between 51 and 64 are only partially supportive of a stream's aquatic life use designation (IDEM, 2000).

Habitat Result and Discussion

Table 12 lists the QHEI scores for the Coffee Creek watershed sites. (Attachment 2 provides QHEI data sheets.) The Coffee Creek Center Development site (Site 3) received the highest score, 53. Well developed pools and riffles, stable substrate, and available in-stream and canopy cover characterized this reach. Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4) received the lowest scores, 26 and 23, respectively. Poor substrate, lack of sinuosity or stability, and undeveloped pools and riffles limited the available habitat at both these reaches. Generally, Coffee Creek mainstem reaches (1, 3, 6, and 8) scored higher in all metrics than reaches assessed in tributaries (Figure 8). The low tributary QHEI scores suggest that these reaches may not be capable of supporting healthy aquatic invertebrate community.

Table 12. QHEI Scores for the Coffee Creek watershed sampling reaches as sampled June 30, 2002.

Site	Substrate Score	Cover Score	Channel Score	Riparian Score	Pool Score	Riffle Score	Gradient Score	Total Score
Maximum Possible Score	**20**	**20**	**20**	**10**	**10**	**10**	**10**	**100**
Site 1-Coffee Creek	7	9	10	5.95	3	3	10	**48**
Site 2-Pope O'Connor Ditch	1	10	4	9.25	0	0	2	**26**
Site 3-Coffee Creek	14	4	11	7.75	4	6	6	**53**
Site 4-Shooter Ditch	1	5	4	5	0	0	8	**23**
Site 5-Johnson Ditch	11	4	4	7.5	0	0	10	**37**
Site 6-Coffee Creek	13	6	8	9.5	2	0	4	**43**
Site 7-Suman Road Tributary	13	4	8	7.5	0	2	8	**43**
Site 8-Coffee Creek	9	5	13.5	8	3	3	8	**50**

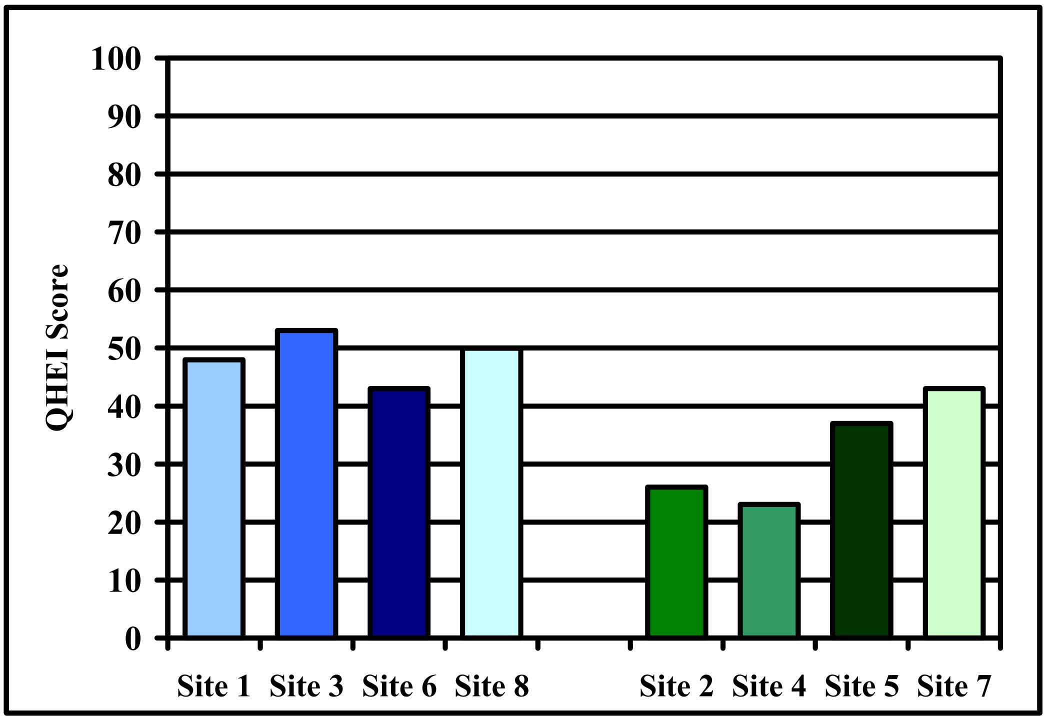

Figure 8. Qualitative habitat evaluation index scores assessed at Coffee Creek watershed reaches.

The habitat scores repeat the same pattern observed in the water chemistry and macroinvertebrate community data: the tributaries are in worse condition than the Coffee Creek mainstem. Coffee Creek at the Coffee Creek Center (Site 3) possessed the best in-stream and riparian habitat as measured by the QHEI. Similarly, the site exhibited good water chemistry, especially with respect to other sites in the watershed. These factors undoubtedly helped create an environment suitable for a well balanced macroinvertebrate community. The site's relatively high fall mIBI score suggests the site does support a macroinvertebrate community that is of high enough quality to meet the stream's aquatic life use designation. In contrast, poor habitat and water quality in Shooter (Site 4) and Pope O'Connor (Site 2) Ditches created an inhospitable environment for macroinvertebrates. mIBI scores at these sites reflect this. It is important to note that both Shooter Ditch and Pope O'Connor Ditch have been heavily modified. It is likely that changes in their hydrology also play a large role in shaping the macroinvertebrate communities in these ditches.

Water Quality Assessment Summary

Water quality conditions were generally better in the Coffee Creek mainstem, particularly the middle section of the mainstem (Sites 3 and 6), compared to the water quality conditions in the Coffee Creek tributaries. With respect to water chemistry, nutrient concentrations were closer to the Ohio EPA's standards to protect aquatic life (Indiana does not possess numeric nutrient criteria) and dissolved oxygen concentrations were sufficient to protect salmonid species in the mainstem. High water temperatures observed in July 2002 and the *E. coli* concentrations that exceeded the state standard were the water chemistry issues of most concern in Coffee Creek's mainstem. Habitat scores were also higher in the mainstem compared to the tributaries. QHEI scores ranged from 43 (Coffee Creek at Mander Road; Site 6) to 53 (Coffee Creek at Coffee Creek Center; Site 3) at the mainstem sites, suggesting moderate impairment of the in-stream and riparian habitat. The macroinvertebrate communities found at the mainstem sites reflected the better water chemistry and habitat conditions. mIBI scores ranged from low of 0.4 (Coffee Creek headwaters; Fall 2002) indicating severe impairment to a high of 5.2 (Coffee Creek at Coffee Creek Center; Fall 2002) indicating only slight impairment. mIBI scores in Coffee Creek at the Coffee Creek Center (Site 3) and Coffee Creek at Mander Road (Site 6) were consistently higher than the tributaries. The Fall mIBI score in Coffee Creek at the Coffee Creek Center (Site 3) suggested this reach is capable of supporting its aquatic life use designation. mIBI scores in Coffee Creek at Mander Road and near its confluence with the Little Calumet River indicated that these reaches were at least partially supportive of the creek's aquatic life use designation.

Coffee Creek tributaries, Shooter Ditch, Johnson Ditch, Pope O'Connor Ditch and the Suman Road Tributary, generally possessed poorer water quality conditions than the Coffee Creek mainstem. Nutrient concentrations in Shooter Ditch (Site 4) and Pope O'Connor Ditch (Site 2) were generally higher than those observed in the Coffee Creek mainstem and other tributaries. Nitrate-nitrogen and total phosphorus levels in these tributaries exceeded Ohio EPA numeric criteria set to protect aquatic life. These same tributaries also exhibited low oxygen levels. The high nutrient levels are likely imparing the aquatic communities in Shooter and Pope O'Connor Ditches and preventing the use of these waterbodies by mainstem biota as refuges. High ammonia-nitorgen and high total phosphorus levels were also observed in the Coffee Creek headwaters (Site 8) and Johnson Ditch (Site 5) respectively. Total susupended solids concentrations were of concern in Shooter Ditch (Site 4) and the Suman Road Tributary (Site 7). *E. coli* concentrations were generally higher in the tributaries compared to the mainstem.

Macroinvertebrate communities in the tributaries typically reflected the poor water chemistry conditions described above. mIBI scores ranged from a low of 0.4 (Pope O'Connor Ditch; Spring 2002 and Shooter Ditch; Fall 2002) indicating severe impairment to a high of 3.4 (Suman Road Tributary; Fall 2002) indicating moderate impairment. The macroinvertebrate communities in Pope O'Connor Ditch and Shooter Ditch were characterized by a dominance of tolerant organisms and overall low diversity. The Suman Road Tributary's fall sampling suggested the site possessed at least moderate diversity with an average number of more sensitive taxa. Poor habitat in the tributaries likely also shaped the macroinvertebrate communities in the tributaries. Tributary QHEI scores ranged from a low of 23 (Shooter Ditch) to a high of 43 (Suman Road Tributary). Although it was not measured as a part of this study, hydrological modifications, particularly in Shooter Ditch and Pope O'Connor Ditch likely limit the biotic integrity in these ditches as well.

The results of the water quality assessment indicate that watershed management efforts should focus on a two-fold objective: 1. maintain water quality in the mainstem and 2. improve water quality in the creek's tributaries. Of particular importance in protecting the mainstem is limiting the input of nutrients, maintaining/increasing canopy cover to limit heat gain by the mainstem, improving in-stream and riparian habitat, using new technology to prevent development of the watershed from increasing thermal pollution to the mainstem, and reducing the input of pathogens to the creek. Restoration/enhancement of the tributaries should focus on Pope O'Connor Ditch and Shooter Ditch first. These tributaries exhibited the poorest water quality and therefore possess the greatest potential to impair the mainstem's water quality. Additionally, management efforts should target sediment loss prevention from the Suman Road Tributary subwatershed as sediment loading data suggest this tributary may be delivering more sediment than other tributaries to the mainstem.

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ATTACHMENT 1:

mIBI Scores and Calculation

The lack of suitable habitat and substrate in Pope O'Connor Ditch (Site 2) and Shooter Ditch (Site 4) prohibited the use of the IDEM mIBI sampling protocol. Consequently, when the mIBI scores were calculated for these sites, the protocol dependent metrics (number of taxa, number of individuals, EPT Index, EPT Count, and chironomid count) were not included in the metric classification score averaging. (This is indicated in the scoring tables by a double dash (--)).. Eliminating the protocol dependent metrics allows the mIBI scores at sites surveyed using different survey protocols to be compared to mIBI scores at sites sampled using the IDEM recommended protocol (Steve Newhouse, IDEM Biological Surveys Section, email correspondence).

Table F.1. Spring Coffee Creek at Old State Road 49 mIBI score.

Metric		**Metric Score**
HBI Score	4.81	4
Number of Taxa	9	2
Total Number of Individuals	88	2
% Dominant Taxa	58.0	2
EPT Index	3	2
EPT Count	11	0
EPT:Individuals	0.13	0
EPT:Chironomidae	1.22	2
Chironomidae Count	9	6
Number Individuals Per Square	2.8	0
mIBI Score		**2.00**

Table F.2. Spring Pope O'Conner Ditch mIBI score.

Metric		**Metric Score**
HBI Score	7.98	0
Number of Taxa	--	--
Total Number of Individuals	--	--
% Dominant Taxa	87.4	0
EPT Index	--	--
EPT Count	--	--
EPT:Individuals	0	0
EPT:Chironomidae	0	0
Chironomidae Count	--	--
Number Individuals Per Square	33.4	2
mIBI Score		**0.40**

Table F.3. Spring Coffee Creek in Coffee Creek Center Development mIBI score.

Metric		Metric Score
HBI Score	4.65	4
Number of Taxa	9	2
Total Number of Individuals	103	2
% Dominant Taxa	35.0	4
EPT Index	3	2
EPT Count	50	4
EPT:Individuals	0.49	6
EPT:Chironomidae	5	4
Chironomidae Count	10	6
Number Individuals Per Square	6.44	0
mIBI Score		**3.40**

Table F.4. Spring Shooter Ditch mIBI score.

Metric		Metric Score
HBI Score	7.93	0
Number of Taxa	--	--
Total Number of Individuals	--	--
% Dominant Taxa	44.8	2
EPT Index	--	--
EPT Count	--	--
EPT:Individuals	0.01	0
EPT:Chironomidae	0.43	0
Chironomidae Count	--	--
Number Individuals Per Square	83.3	4
mIBI Score		**1.20**

Table F.5 Spring Johnson Ditch mIBI score.

Metric		Metric Score
HBI Score	5.92	0
Number of Taxa	5	0
Total Number of Individuals	100	2
% Dominant Taxa	87.0	0
EPT Index	0	0
EPT Count	0	0
EPT:Individuals	0	0
EPT:Chironomidae	0	0
Chironomidae Count	2	8
Number Individuals Per Square	--	--
mIBI Score		**1.11**

Table F6. Spring Coffee Creek at Mander Road mIBI score.

Metric		Metric Score
HBI Score	4.22	6
Number of Taxa	8	2
Total Number of Individuals	99	2
% Dominant Taxa	73.7	0
EPT Index	3	2
EPT Count	13	0
EPT:Individuals	0.13	0
EPT:Chironomidae	13	8
Chironomidae Count	1	8
Number Individuals Per Square	4.71	0
mIBI Score		**2.80**

Table F7. Spring Suman Road tributary mIBI score.

Metric		Metric Score
HBI Score	4.22	6
Number of Taxa	5	0
Total Number of Individuals	110	2
% Dominant Taxa	90.9	0
EPT Index	1	0
EPT Count	1	0
EPT:Individuals	0.01	0
EPT:Chironomidae	0.50	0
Chironomidae Count	2	8
Number Individuals Per Square	27.5	0
mIBI Score		**1.60**

Table F.8. Fall Coffee Creek at Old State Road 49 mIBI score.

Metric		Metric Score
HBI Score	5.47	2
Number of Taxa	12	4
Total Number of Individuals	80	2
% Dominant Taxa	27.5	6
EPT Index	3	2
EPT Count	11	0
EPT:Individuals	0.14	2
EPT:Chironomidae	0.65	0
Chironomidae Count	17	6
Number Individuals Per Square	3.2	0
mIBI Score		**2.40**

Table F.9. Fall Coffee Creek in Coffee Creek Center Development mIBI score.

Metric		Metric Score
HBI Score	3.67	8
Number of Taxa	8	2
Total Number of Individuals	142	4
% Dominant Taxa	40.8	4
EPT Index	4	4
EPT Count	113	6
EPT:Individuals	0.8	8
EPT:Chironomidae	18.8	8
Chironomidae Count	6	8
Number Individuals Per Square	17.75	0
mIBI Score		**5.20**

Table F.10. Fall Shooter Ditch mIBI score.

Metric		Metric Score
HBI Score	7.76	0
Number of Taxa	--	--
Total Number of Individuals	--	--
% Dominant Taxa	49.1	2
EPT Index	--	--
EPT Count	--	--
EPT:Individuals	0.00	0
EPT:Chironomidae	0.00	0
Chironomidae Count	--	--
Number Individuals Per Square	6.4	0
mIBI Score		**0.40**

Table F.11. Fall Johnson Ditch mIBI score.

Metric		Metric Score
HBI Score	5.13	2
Number of Taxa	15	6
Total Number of Individuals	75	0
% Dominant Taxa	29.3	6
EPT Index	3	2
EPT Count	14	0
EPT:Individuals	0.18	2
EPT:Chironomidae	1.00	2
Chironomidae Count	14	6
Number Individuals Per Square	3.4	0
mIBI Score		**2.60**

Table F.12. Fall Coffee Creek at Mander Road mIBI score.

Metric		Metric Score
HBI Score	4.23	6
Number of Taxa	14	4
Total Number of Individuals	111	2
% Dominant Taxa	54.9	4
EPT Index	4	2
EPT Count	31	4
EPT:Individuals	0.28	2
EPT:Chironomidae	31	8
Chironomidae Count	1	8
Number Individuals Per Square	11.1	0
mIBI Score		**4.00**

Table F.13. Fall Suman Road tributary mIBI score.

Metric		Metric Score
HBI Score	4.09	6
Number of Taxa	7	0
Total Number of Individuals	183	4
% Dominant Taxa	70.5	0
EPT Index	3	2
EPT Count	39	2
EPT:Individuals	0.21	2
EPT:Chironomidae	39	8
Chironomidae Count	1	8
Number Individuals Per Square	30.50	2
mIBI Score		**3.40**

Table F.14. Fall Coffee Creek headwaters mIBI score.

Metric		Metric Score
HBI Score	4.60	4
Number of Taxa	3	0
Total Number of Individuals	79	0
% Dominant Taxa	65.8	0
EPT Index	0	0
EPT Count	0	0
EPT:Individuals	0.00	0
EPT:Chironomidae	0.00	0
Chironomidae Count	0	0
Number Individuals Per Square	3.2	0
mIBI Score		**0.40**

ATTACHMENT 2:

QHEI Datasheets

STREAM: Coffee Creek--Site 1 **RIVER MILE:** ______ **DATE:** 6/13/2002 **QHEI SCORE** 48

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) **SUBSTRATE SCORE** 7

TYPE			POOL	RIFFLE				POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)			[ ]	[ ]	GRAVEL(7)		
[ ]	[ ]	BOULDER(9)			[X]	[ ]	SAND(6)		
[ ]	[ ]	COBBLE(8)		X	[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	HARDPAN(4)			[ ]	[ ]	DETRITUS(3)		
[ ]	[X]	MUCK/SILT(2)			[ ]	[ ]	ARTIFIC(0)	X	X

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all)
- [ ] LIMESTONE(1) [ ] RIP/RAP(0)
- [X] TILLS(1) [ ] HARDPAN(0)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)

SILT COVER (one)
- [ ] SILT-HEAVY(-2) [X] SILT-MOD(-1)
- [ ] SILT-NORM(0) [ ] SILT-FREE(1)

Extent of Embeddedness (check one)
- [ ] EXTENSIVE(-2) [X] MODERATE(-1)
- [ ] LOW(0) [ ] NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: ______

2) INSTREAM COVER: **COVER SCORE** 9

TYPE (Check all that apply)
- [ ] UNDERCUT BANKS(1)
- [X] OVERHANGING VEGETATION(1)
- [ ] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [X] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)
- [ ] EXTENSIVE >75%(11)
- [X] MODERATE 25-75%(7)
- [ ] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS: ______

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) **CHANNEL SCORE** 10

SINUOSITY
- [ ] HIGH(4)
- [ ] MODERATE(3)
- [X] LOW(2)
- [ ] NONE(1)

DEVELOPMENT
- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [X] FAIR(3)
- [ ] POOR(1)

CHANNELIZATION
- [ ] NONE(6)
- [ ] RECOVERED(4)
- [X] RECOVERING(3)
- [ ] RECENT OR NO RECOVERY(1)

STABILITY
- [ ] HIGH(3)
- [X] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER
- [ ] SNAGGING
- [X] RELOCATION
- [X] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [X] BANK SHAPING

COMMENTS: ______

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) **RIPARIAN SCORE** 6

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[ ]	[X]	MODERATE 30-150 ft.(3)
[X]	[ ]	NARROW 15-30 ft.(2)
[ ]	[ ]	VERY NARROW 3-15 ft.(1)
[ ]	[X]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[ ]	FOREST, SWAMP(3)	[X]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	[X]	[X]	SHRUB OR OLD FIELD(2)
[ ]	[X]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[X]	[X]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS: ______

5) POOL/GLIDE AND RIFFLE/RUN QUALITY **NO POOL = 0** **POOL SCORE** 3

MAX.DEPTH (Check 1)
- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [X] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)
- [ ] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [X] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)
- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [X] MODERATE(1)
- [ ] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS: ______

RIFFLE SCORE 3

RIFFLE/RUN DEPTH
- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [X] GENERALLY 2-4 in.(1)
- [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE
- [X] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] EXTENSIVE(-1)
- [X] MODERATE(0)
- [ ] LOW(1)
- [ ] NONE(2)
- [ ] NO RIFFLE(0)

COMMENTS: ______

6) GRADIENT (FEET/MILE): 8.13 **% POOL** 10% **% RIFFLE** 30% **% RUN** 60% **GRADIENT SCORE** 10

STREAM: Pope O'Conner Ditch--Site 2 **RIVER MILE:** ______ **DATE:** 6/13/2002 **QHEI SCORE** 26

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) **SUBSTRATE SCORE** 1

TYPE			POOL	RIFFLE				POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)			[ ]	[ ]	GRAVEL(7)		
[ ]	[ ]	BOULDER(9)			[ ]	[ ]	SAND(6)		
[ ]	[ ]	COBBLE(8)			[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	HARDPAN(4)			[ ]	[ ]	DETRITUS(3)		
X	X	MUCK/SILT(2)			[ ]	[ ]	ARTIFIC(0)		

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) X <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

SUBSTRATE ORIGIN (all)
- [ ] LIMESTONE(1)
- [ ] RIP/RAP(0)
- X TILLS(1)
- [ ] HARDPAN(0)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)

SILT COVER (one)
- X SILT-HEAVY(-2)
- [ ] SILT-MOD(-1)
- [ ] SILT-NORM(0)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)
- X EXTENSIVE(-2)
- [ ] MODERATE(-1)
- [ ] LOW(0)
- [ ] NONE(1)

COMMENTS: ______

2) INSTREAM COVER: **COVER SCORE** 10

TYPE (Check all that apply)
- [ ] UNDERCUT BANKS(1)
- X OVERHANGING VEGETATION(1)
- [ ] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- X AQUATIC MACROPHYTES(1)
- X LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)
- [ ] EXTENSIVE >75%(11)
- X MODERATE 25-75%(7)
- [ ] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS: ______

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) **CHANNEL SCORE** 4

SINUOSITY
- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- X NONE(1)

DEVELOPMENT
- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- X POOR(1)

CHANNELIZATION
- [ ] NONE(6)
- [ ] RECOVERED(4)
- [ ] RECOVERING(3)
- X RECENT OR NO RECOVERY(1)

STABILITY
- [ ] HIGH(3)
- [ ] MODERATE(2)
- X LOW(1)

MODIFICATION/OTHER
- [ ] SNAGGING
- [ ] IMPOUND
- [ ] RELOCATION
- [ ] ISLAND
- [ ] CANOPY REMOVAL
- [ ] LEVEED
- [ ] DREDGING
- [ ] BANK SHAPING
- [ ] ONE SIDE CHANNEL MODIFICATION

COMMENTS: ______

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) **RIPARIAN SCORE** 9.3

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
X	X	WIDE >150 ft.(4)
X	[ ]	MODERATE 30-150 ft.(3)
[ ]	[ ]	NARROW 15-30 ft.(2)
[ ]	[ ]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	X	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	X	[ ]	SHRUB OR OLD FIELD(2)
[ ]	[ ]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
X	X	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS: ______

5) POOL/GLIDE AND RIFFLE/RUN QUALITY **NO POOL = 0** **POOL SCORE** 0

MAX.DEPTH (Check 1)
- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)
- [ ] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)
- [ ] TORRENTIAL(-1)
- [ ] EDDIES(1)
- [ ] FAST(1)
- [ ] INTERSTITIAL(-1)
- [ ] MODERATE(1)
- [ ] INTERMITTENT(-2)
- [ ] SLOW(1)

COMMENTS: ______

RIFFLE SCORE 0

RIFFLE/RUN DEPTH
- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE
- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] EXTENSIVE(-1)
- [ ] NONE(2)
- [ ] MODERATE(0)
- [ ] NO RIFFLE(0)
- [ ] LOW(1)

COMMENTS: ______

6) GRADIENT (FEET/MILE): 0 **% POOL** 0% **% RIFFLE** 0% **% RUN** 100% **GRADIENT SCORE** 2

STREAM: Coffee Creek--Site 3 **RIVER MILE:** ______ **DATE:** 6/13/2002 **QHEI SCORE** 53

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) **SUBSTRATE SCORE** 14

TYPE			POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)		
[ ]	[ ]	BOULDER(9)		
[ ]	[ ]	COBBLE(8)	X	X
[ ]	[ ]	HARDPAN(4)		
[ ]	[ ]	MUCK/SILT(2)		X
[X]	[ ]	GRAVEL(7)		
[ ]	[X]	SAND(6)	X	X
[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	DETRITUS(3)		
[ ]	[ ]	ARTIFIC(0)		

SUBSTRATE ORIGIN (all): [ ] LIMESTONE(1) [X] TILLS(1) [ ] SANDSTONE(0) [ ] SHALE(-1) [ ] COAL FINES(-2) [ ] RIP/RAP(0) [ ] HARDPAN(0)

SILT COVER (one): [ ] SILT-HEAVY(-2) [X] SILT-NORM(0) [ ] SILT-MOD(-1) [ ] SILT-FREE(1)

Extent of Embeddedness (check one): [ ] EXTENSIVE(-2) [X] LOW(0) [ ] MODERATE(-1) [ ] NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: ______

2) INSTREAM COVER: **COVER SCORE** 4

TYPE (Check all that apply)

[ ] UNDERCUT BANKS(1)
[X] OVERHANGING VEGETATION(1)
[ ] SHALLOWS (IN SLOW WATER)(1)
[ ] DEEP POOLS(2)
[ ] ROOTWADS(1)
[ ] BOULDERS(1)
[ ] OXBOWS(1)
[ ] AQUATIC MACROPHYTES(1)
[ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

[ ] EXTENSIVE >75%(11)
[ ] MODERATE 25-75%(7)
[X] SPARSE 5-25%(3)
[ ] NEARLY ABSENT <5%(1)

COMMENTS: ______

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) **CHANNEL SCORE** 11

SINUOSITY: [ ] HIGH(4) [X] MODERATE(3) [ ] LOW(2) [ ] NONE(1)

DEVELOPMENT: [ ] EXCELLENT(7) [ ] GOOD(5) [X] FAIR(3) [ ] POOR(1)

CHANNELIZATION: [ ] NONE(6) [ ] RECOVERED(4) [X] RECOVERING(3) [ ] RECENT OR NO RECOVERY(1)

STABILITY: [ ] HIGH(3) [X] MODERATE(2) [ ] LOW(1)

MODIFICATION/OTHER: [ ] SNAGGING [ ] RELOCATION [ ] CANOPY REMOVAL [ ] DREDGING [ ] ONE SIDE CHANNEL MODIFICATION [ ] IMPOUND [ ] ISLAND [ ] LEVEED [X] BANK SHAPING

COMMENTS: ______

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) **RIPARIAN SCORE** 7.8

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	
[ ]	[ ]	WIDE >150 ft.(4)
[X]	[X]	MODERATE 30-150 ft.(3)
[ ]	[ ]	NARROW 15-30 ft.(2)
[ ]	[ ]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY (most predominant per bank)

L	R		L	R	
[X]	[ ]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	[ ]	[X]	SHRUB OR OLD FIELD(2)
[X]	[X]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION (per bank)

L	R	
[X]	[X]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS: ______

5) POOL/GLIDE AND RIFFLE/RUN QUALITY **NO POOL = 0** **POOL SCORE** 4

MAX.DEPTH (Check 1): [ ] >4 ft.(6) [ ] 2.4-4 ft.(4) [X] 1.2-2.4 ft.(2) [ ] <1.2 ft.(1) [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1): [ ] POOL WIDTH>RIFFLE WIDTH(2) [ ] POOL WIDTH=RIFFLE WIDTH(1) [X] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply): [ ] TORRENTIAL(-1) [X] FAST(1) [X] MODERATE(1) [ ] SLOW(1) [ ] EDDIES(1) [ ] INTERSTITIAL(-1) [ ] INTERMITTENT(-2)

COMMENTS: ______

RIFFLE SCORE 6

RIFFLE/RUN DEPTH: [ ] GENERALLY >4 in. MAX.>20 in.(4) [X] GENERALLY >4 in. MAX.<20 in.(3) [ ] GENERALLY 2-4 in.(1) [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE: [X] STABLE (e.g., Cobble,Boulder)(2) [ ] MOD.STABLE (e.g., Pea Gravel)(1) [ ] UNSTABLE (Gravel, Sand)(0) [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS: [ ] EXTENSIVE(-1) [ ] MODERATE(0) [X] LOW(1) [ ] NONE(2) [ ] NO RIFFLE(0)

COMMENTS: ______

6) GRADIENT (FEET/MILE): 5.9 **% POOL** 15% **% RIFFLE** 25% **% RUN** 60% **GRADIENT SCORE** 6

STREAM: Shooter Ditch--Site 4 **RIVER MILE:** ______ **DATE:** 6/13/2002 **QHEI SCORE** 23

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) **SUBSTRATE SCORE** 1

TYPE			POOL	RIFFLE				POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)			[ ]	[ ]	GRAVEL(7)		
[ ]	[ ]	BOULDER(9)			[ ]	[ ]	SAND(6)		
[ ]	[ ]	COBBLE(8)			[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	HARDPAN(4)			[ ]	[ ]	DETRITUS(3)		
[X]	[X]	MUCK/SILT(2)			[ ]	[ ]	ARTIFIC(0)		

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all)
- [ ] LIMESTONE(1) [ ] RIP/RAP(0)
- [X] TILLS(1) [ ] HARDPAN(0)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)

SILT COVER (one)
- [X] SILT-HEAVY(-2) [ ] SILT-MOD(-1)
- [ ] SILT-NORM(0) [ ] SILT-FREE(1)

Extent of Embeddedness (check one)
- [X] EXTENSIVE(-2) [ ] MODERATE(-1)
- [ ] LOW(0) [ ] NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS:

2) INSTREAM COVER: **COVER SCORE** 5

TYPE (Check all that apply)
- [ ] UNDERCUT BANKS(1) [ ] DEEP POOLS(2) [ ] OXBOWS(1)
- [X] OVERHANGING VEGETATION(1) [ ] ROOTWADS(1) [X] AQUATIC MACROPHYTES(1)
- [ ] SHALLOWS (IN SLOW WATER)(1) [ ] BOULDERS(1) [ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)
- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS: Heavy algal growth

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) **CHANNEL SCORE** 4

SINUOSITY
- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- [X] NONE(1)

DEVELOPMENT
- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- [X] POOR(1)

CHANNELIZATION
- [ ] NONE(6)
- [ ] RECOVERED(4)
- [ ] RECOVERING(3)
- [X] RECENT OR NO RECOVERY(1)

STABILITY
- [ ] HIGH(3)
- [ ] MODERATE(2)
- [X] LOW(1)

MODIFICATION/OTHER
- [ ] SNAGGING [ ] IMPOUND
- [ ] RELOCATION [ ] ISLAND
- [ ] CANOPY REMOVAL [ ] LEVEED
- [ ] DREDGING [ ] BANK SHAPING
- [ ] ONE SIDE CHANNEL MODIFICATION

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) **RIPARIAN SCORE** 5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[ ]	[ ]	MODERATE 30-150 ft.(3)
[ ]	[ ]	NARROW 15-30 ft.(2)
[X]	[X]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[ ]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	[ ]	[ ]	SHRUB OR OLD FIELD(2)
[X]	[X]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[X]	[X]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY **NO POOL = 0** **POOL SCORE** 0

MAX.DEPTH (Check 1)
- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)
- [ ] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)
- [ ] TORRENTIAL(-1) [ ] EDDIES(1)
- [ ] FAST(1) [ ] INTERSTITIAL(-1)
- [ ] MODERATE(1) [ ] INTERMITTENT(-2)
- [ ] SLOW(1)

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH
- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE
- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] EXTENSIVE(-1) [ ] NONE(2)
- [ ] MODERATE(0) [ ] NO RIFFLE(0)
- [ ] LOW(1)

COMMENTS:

6) GRADIENT (FEET/MILE): 14.6 **% POOL** 0% **% RIFFLE** 0% **% RUN** 100% **GRADIENT SCORE** 8

STREAM: Johnson Ditch--Site 5 **RIVER MILE:** ______ **DATE:** 6/13/2002 **QHEI SCORE** 37

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) **SUBSTRATE SCORE** 11

TYPE			POOL	RIFFLE				POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)			[X]	[ ]	GRAVEL(7)		
[ ]	[ ]	BOULDER(9)			[ ]	[X]	SAND(6)		
[ ]	[ ]	COBBLE(8)		X	[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	HARDPAN(4)			[ ]	[ ]	DETRITUS(3)		
[ ]	[ ]	MUCK/SILT(2)		X	[ ]	[ ]	ARTIFIC(0)		

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

SUBSTRATE ORIGIN (all)
- [ ] LIMESTONE(1)
- [X] TILLS(1)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)
- [ ] RIP/RAP(0)
- [ ] HARDPAN(0)

SILT COVER (one)
- [ ] SILT-HEAVY(-2)
- [X] SILT-MOD(-1)
- [ ] SILT-NORM(0)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)
- [X] EXTENSIVE(-2)
- [ ] MODERATE(-1)
- [ ] LOW(0)
- [ ] NONE(1)

COMMENTS:

2) INSTREAM COVER: **COVER SCORE** 4

TYPE (Check all that apply)
- [ ] UNDERCUT BANKS(1)
- [ ] OVERHANGING VEGETATION(1)
- [ ] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [X] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)
- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) **CHANNEL SCORE** 4

SINUOSITY
- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- [X] NONE(1)

DEVELOPMENT
- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- [X] POOR(1)

CHANNELIZATION
- [ ] NONE(6)
- [ ] RECOVERED(4)
- [ ] RECOVERING(3)
- [X] RECENT OR NO RECOVERY(1)

STABILITY
- [ ] HIGH(3)
- [ ] MODERATE(2)
- [X] LOW(1)

MODIFICATION/OTHER
- [ ] SNAGGING
- [ ] RELOCATION
- [ ] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [ ] BANK SHAPING

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) **RIPARIAN SCORE** 7.5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
X	X	WIDE >150 ft.(4)
		MODERATE 30-150 ft.(3)
		NARROW 15-30 ft.(2)
X	X	VERY NARROW 3-15 ft.(1)
		NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
X	X	FOREST, SWAMP(3)			URBAN OR INDUSTRIAL(0)
		OPEN PASTURE/ROW CROP(0)			SHRUB OR OLD FIELD(2)
X	X	RESID.,PARK,NEW FIELD(1)			CONSERV. TILLAGE(1)
		FENCED PASTURE(1)			MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
X	X	NONE OR LITTLE(3)
		MODERATE(2)
		HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY **NO POOL = 0** **POOL SCORE** 0

MAX.DEPTH (Check 1)
- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)
- [ ] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)
- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [ ] MODERATE(1)
- [ ] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS:

RIFFLE SCORE 0

RIFFLE/RUN DEPTH
- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE
- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] EXTENSIVE(-1)
- [ ] MODERATE(0)
- [ ] LOW(1)
- [ ] NONE(2)
- [ ] NO RIFFLE(0)

COMMENTS: Shallow riffle (<2 inches) deep has lost its function

6) GRADIENT (FEET/MILE): 28.2 **% POOL** 0% **% RIFFLE** 30% **% RUN** 70% **GRADIENT SCORE** 10

STREAM: Coffee Creek--Site 6 **RIVER MILE:** ______ **DATE:** 6/13/2002 **QHEI SCORE** 43

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 13

TYPE			POOL	RIFFLE	TYPE			POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)			[ ]	[ ]	GRAVEL(7)	X	X
[ ]	[ ]	BOULDER(9)			[X]	[X]	SAND(6)		
[ ]	[ ]	COBBLE(8)			[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	HARDPAN(4)			[ ]	[ ]	DETRITUS(3)		
[ ]	[ ]	MUCK/SILT(2)			[ ]	[ ]	ARTIFIC(0)		

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all)
- [ ] LIMESTONE(1)
- [X] TILLS(1)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)
- [ ] RIP/RAP(0)
- [ ] HARDPAN(0)

SILT COVER (one)
- [ ] SILT-HEAVY(-2)
- [X] SILT-NORM(0)
- [ ] SILT-MOD(-1)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)
- [ ] EXTENSIVE(-2)
- [X] LOW(0)
- [ ] MODERATE(-1)
- [ ] NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: ______

2) INSTREAM COVER:

COVER SCORE 6

TYPE (Check all that apply)
- [X] UNDERCUT BANKS(1)
- [X] OVERHANGING VEGETATION(1)
- [ ] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [X] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)
- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS: ______

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 8

SINUOSITY
- [ ] HIGH(4)
- [ ] MODERATE(3)
- [X] LOW(2)
- [ ] NONE(1)

DEVELOPMENT
- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- [X] POOR(1)

CHANNELIZATION
- [ ] NONE(6)
- [ ] RECOVERED(4)
- [X] RECOVERING(3)
- [ ] RECENT OR NO RECOVERY(1)

STABILITY
- [ ] HIGH(3)
- [X] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER
- [ ] SNAGGING
- [ ] RELOCATION
- [ ] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [ ] BANK SHAPING

COMMENTS: ______

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 9.5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
X	X	WIDE >150 ft.(4)
		MODERATE 30-150 ft.(3)
		NARROW 15-30 ft.(2)
		VERY NARROW 3-15 ft.(1)
		NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
	X	FOREST, SWAMP(3)			URBAN OR INDUSTRIAL(0)
		OPEN PASTURE/ROW CROP(0)	X		SHRUB OR OLD FIELD(2)
		RESID.,PARK,NEW FIELD(1)			CONSERV. TILLAGE(1)
		FENCED PASTURE(1)			MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
X	X	NONE OR LITTLE(3)
		MODERATE(2)
		HEAVY OR SEVERE(1)

COMMENTS: ______

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 2

MAX.DEPTH (Check 1)
- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [X] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)
- [ ] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [X] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)
- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [X] MODERATE(1)
- [ ] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS: ______

RIFFLE SCORE 0

RIFFLE/RUN DEPTH
- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE
- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] EXTENSIVE(-1)
- [ ] MODERATE(0)
- [ ] LOW(1)
- [ ] NONE(2)
- [ ] NO RIFFLE(0)

COMMENTS: ______

6) GRADIENT (FEET/MILE): 70.4

% POOL 5% % RIFFLE 0% % RUN 95% **GRADIENT SCORE** 4

STREAM: Suman Road Tributary--Site 7 **RIVER MILE:** ______ **DATE:** 6/13/2002 **QHEI SCORE** 43

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) **SUBSTRATE SCORE** 13

TYPE			POOL	RIFFLE				POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)			[X]	[ ]	GRAVEL(7)		
[ ]	[ ]	BOULDER(9)			[ ]	[X]	SAND(6)		
[ ]	[ ]	COBBLE(8)			[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	HARDPAN(4)			[ ]	[ ]	DETRITUS(3)		
[ ]	[ ]	MUCK/SILT(2)			[ ]	[ ]	ARTIFIC(0)		

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all): [ ] LIMESTONE(1) [ ] RIP/RAP(0) [X] TILLS(1) [ ] HARDPAN(0) [ ] SANDSTONE(0) [ ] SHALE(-1) [ ] COAL FINES(-2)

SILT COVER (one): [ ] SILT-HEAVY(-2) [ ] SILT-MOD(-1) [X] SILT-NORM(0) [ ] SILT-FREE(1)

Extent of Embeddedness (check one): [ ] EXTENSIVE(-2) [ ] MODERATE(-1) [X] LOW(0) [ ] NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS:

2) INSTREAM COVER: **COVER SCORE** 4

TYPE (Check all that apply)

- [ ] UNDERCUT BANKS(1)
- [X] OVERHANGING VEGETATION(1)
- [ ] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS:

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) **CHANNEL SCORE** 8

SINUOSITY: [ ] HIGH(4) [ ] MODERATE(3) [X] LOW(2) [ ] NONE(1)

DEVELOPMENT: [ ] EXCELLENT(7) [ ] GOOD(5) [ ] FAIR(3) [X] POOR(1)

CHANNELIZATION: [ ] NONE(6) [ ] RECOVERED(4) [X] RECOVERING(3) [ ] RECENT OR NO RECOVERY(1)

STABILITY: [ ] HIGH(3) [X] MODERATE(2) [ ] LOW(1)

MODIFICATION/OTHER: [ ] SNAGGING [ ] RELOCATION [ ] CANOPY REMOVAL [ ] DREDGING [ ] ONE SIDE CHANNEL MODIFICATION [ ] IMPOUND [ ] ISLAND [ ] LEVEED [ ] BANK SHAPING

COMMENTS:

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) **RIPARIAN SCORE** 7.5

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[X]	[ ]	WIDE >150 ft.(4)
[ ]	[ ]	MODERATE 30-150 ft.(3)
[ ]	[X]	NARROW 15-30 ft.(2)
[ ]	[ ]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[ ]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	[X]	[ ]	SHRUB OR OLD FIELD(2)
[ ]	[X]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[X]	[X]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY **NO POOL = 0** **POOL SCORE** 0

MAX.DEPTH (Check 1): [ ] >4 ft.(6) [ ] 2.4-4 ft.(4) [ ] 1.2-2.4 ft.(2) [ ] <1.2 ft.(1) [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1): [ ] POOL WIDTH>RIFFLE WIDTH(2) [ ] POOL WIDTH=RIFFLE WIDTH(1) [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply): [ ] TORRENTIAL(-1) [ ] FAST(1) [ ] MODERATE(1) [ ] SLOW(1) [ ] EDDIES(1) [ ] INTERSTITIAL(-1) [ ] INTERMITTENT(-2)

COMMENTS:

RIFFLE SCORE 2

RIFFLE/RUN DEPTH: [ ] GENERALLY >4 in. MAX.>20 in.(4) [ ] GENERALLY >4 in. MAX.<20 in.(3) [X] GENERALLY 2-4 in.(1) [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE: [ ] STABLE (e.g., Cobble,Boulder)(2) [ ] MOD.STABLE (e.g., Pea Gravel)(1) [X] UNSTABLE (Gravel, Sand)(0) [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS: [ ] EXTENSIVE(-1) [ ] MODERATE(0) [X] LOW(1) [ ] NONE(2) [ ] NO RIFFLE(0)

COMMENTS:

6) GRADIENT (FEET/MILE): 38.4 **% POOL** 0% **% RIFFLE** 10% **% RUN** 90% **GRADIENT SCORE** 8

STREAM: Coffee Creek--Site 8 **RIVER MILE:** ______ **DATE:** 6/13/2002 **QHEI SCORE** 50

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)

SUBSTRATE SCORE 9

TYPE			POOL	RIFFLE	TYPE			POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)			[X]	[ ]	GRAVEL(7)	X	X
[ ]	[ ]	BOULDER(9)			[ ]	[ ]	SAND(6)		
[ ]	[ ]	COBBLE(8)		X	[ ]	[ ]	BEDROCK(5)		
[ ]	[ ]	HARDPAN(4)			[ ]	[ ]	DETRITUS(3)		X
[ ]	[X]	MUCK/SILT(2)	X	X	[ ]	[ ]	ARTIFIC(0)		

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [X] <4(0)

SUBSTRATE ORIGIN (all): [ ] LIMESTONE(1) [X] TILLS(1) [ ] SANDSTONE(0) [ ] SHALE(-1) [ ] COAL FINES(-2) [ ] RIP/RAP(0) [ ] HARDPAN(0)

SILT COVER (one): [ ] SILT-HEAVY(-2) [X] SILT-MOD(-1) [ ] SILT-NORM(0) [ ] SILT-FREE(1)

Extent of Embeddedness (check one): [ ] EXTENSIVE(-2) [ ] MODERATE(-1) [X] LOW(0) [ ] NONE(1)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: ______

2) INSTREAM COVER:

COVER SCORE 5

TYPE (Check all that apply)

- [ ] UNDERCUT BANKS(1)
- [X] OVERHANGING VEGETATION(1)
- [X] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [X] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS: ______

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)

CHANNEL SCORE 14

SINUOSITY: [ ] HIGH(4) [X] MODERATE(3) [X] LOW(2) [ ] NONE(1)

DEVELOPMENT: [ ] EXCELLENT(7) [X] GOOD(5) [ ] FAIR(3) [ ] POOR(1)

CHANNELIZATION: [ ] NONE(6) [X] RECOVERED(4) [ ] RECOVERING(3) [ ] RECENT OR NO RECOVERY(1)

STABILITY: [ ] HIGH(3) [X] MODERATE(2) [ ] LOW(1)

MODIFICATION/OTHER: [ ] SNAGGING [ ] RELOCATION [ ] CANOPY REMOVAL [ ] DREDGING [ ] ONE SIDE CHANNEL MODIFICATION [ ] IMPOUND [ ] ISLAND [ ] LEVEED [ ] BANK SHAPING

COMMENTS: ______

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)

RIPARIAN SCORE 8

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[X]	[X]	MODERATE 30-150 ft.(3)
[ ]	[ ]	NARROW 15-30 ft.(2)
[ ]	[ ]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[X]	[X]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	[ ]	[ ]	SHRUB OR OLD FIELD(2)
[ ]	[ ]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[ ]	[ ]	NONE OR LITTLE(3)
[X]	[X]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS: ______

5) POOL/GLIDE AND RIFFLE/RUN QUALITY

NO POOL = 0 **POOL SCORE** 3

MAX.DEPTH (Check 1): [ ] >4 ft.(6) [ ] 2.4-4 ft.(4) [ ] 1.2-2.4 ft.(2) [X] <1.2 ft.(1) [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1): [ ] POOL WIDTH>RIFFLE WIDTH(2) [X] POOL WIDTH=RIFFLE WIDTH(1) [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply): [ ] TORRENTIAL(-1) [ ] FAST(1) [X] MODERATE(1) [ ] SLOW(1) [ ] EDDIES(1) [ ] INTERSTITIAL(-1) [ ] INTERMITTENT(-2)

COMMENTS: ______

RIFFLE SCORE 3

RIFFLE/RUN DEPTH: [ ] GENERALLY >4 in. MAX.>20 in.(4) [ ] GENERALLY >4 in. MAX.<20 in.(3) [X] GENERALLY 2-4 in.(1) [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE: [ ] STABLE (e.g., Cobble,Boulder)(2) [X] MOD.STABLE (e.g., Pea Gravel)(1) [ ] UNSTABLE (Gravel, Sand)(0) [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS: [ ] EXTENSIVE(-1) [ ] MODERATE(0) [X] LOW(1) [ ] NONE(2) [ ] NO RIFFLE(0)

COMMENTS: ______

6) GRADIENT (FEET/MILE): 39.8

% POOL 20% % RIFFLE 30% % RUN 50% **GRADIENT SCORE** 8

APPENDIX G:

Quality Assurance Project Plan

OFFICE OF WATER MANAGEMENT IDEM
AUG 8 2 07 PM '01

Quality Assurance Project Plan
For
Coffee Creek Watershed Management Plan
In
Porter County, Indiana
A305-1-00-200

Prepared by:

J.F. New & Associates, Inc.

Prepared for:

Indiana Department of Environmental Management
Office of Water Management
Watershed Management Section

Final Draft
August 6, 2001

Approved By:

Project Manager: Nicole M Kalkb ______ 8/6/01
Nicole Kalkbrenner — Date

WMS QA Manager: Jody Arthur ______ 8/8/01
Jody Arthur — Date

WMS Section Chief: ______ 8/8/01
Jill Reinhart — Date

Planning Branch Chief: Mary Ellen Gray ______ 8/20/01
Mary Ellen Gray — Date

TABLE OF CONTENTS

DISTRIBUTION LIST

i. **Robert Wolfe, Project Director, J.F. New & Associates, Inc.**
P.O. Box 243
Walkerton, IN 46574

ii. **Jody Arthur, Quality Assurance Manager, Indiana Dept. of Environmental Management (IDEM)**
IDEM Watershed Management Section
100 North Senate Avenue
P.O. Box 6015
Indianapolis, Indiana 46206-6015

iii. **Katie Rizer, Executive Director, Coffee Creek Watershed Conservancy (CCWC)**
219 B.S. Calumet Road
Chesterton, IN 46304

iv. **Tom Anderson, President, Coffee Creek Watershed Conservancy**
219 B.S. Calumet Road
Chesterton, IN 46304

v. **Nicole Kalkbrener, Project Manager, J.F. New & Associates, Inc.**
P.O. Box 243
Walkerton, IN 46574

vi. **Marianne Giolitto, Technical Manager, J.F. New & Associates, Inc.**
P.O. Box 243
Walkerton, IN 46574

vii. **Brian Majka, Project Technician, J.F. New & Associates, Inc.**
P.O. Box 243
Walkerton, IN 46574

viii. **Cornelia Sawatzky, Project Technician, J.F. New & Associates, Inc.**
P.O. Box 243
Walkerton, IN 46574

ix. **Steve Zimmerman, Project Technician, J.F. New & Associates, Inc.**
P.O. Box 243
Walkerton, IN 46574

SECTION 1: PROJECT DESCRIPTION

Historical Information

The Coffee Creek watershed encompassing approximately 16 square miles lies within the southern portion of the Great Lakes Basin (Figure 1). A subwatershed of the Little Calumet River, the Coffee Creek watershed extends in a northwesterly direction from its headwaters east of Valparaiso to the watershed's mouth at the Little Calumet River near Chesterton, Indiana. From the Little Calumet River, the water flows through the biologically rich Indiana Dunes National Lakeshore and eventually into the southern end of Lake Michigan. Before the development of the residential areas and surrounding farms, Coffee Creek, fed by countless seeps and springs, meandered slowly through a seamless landscape of open woodlands, savannas and prairies.

Over time, the effects of commercial and residential development and agriculture have altered the watershed as well as the creek's original character. The construction of buildings and roads has resulted in an increase in impervious surface area within the watershed and consequently an increase in the volume of surface water discharging into the creek. The straightening and dredging of stream channels in addition to the installation of drain tile systems altered natural drainage patterns throughout the watershed. Monocultures of row crop, fertilizers, herbicides, and pesticides have also negatively affected the local ecosystem of the historic Coffee Creek corridor. Several millponds, built near the turn of the century, have altered the creek's natural hydrology, changing riparian plant communities and the stream's morphology.

Today, the Little Calumet Region, of which the Coffee Creek watershed is a part, exists as a unique mosaic of globally rare natural communities and significant historic features in conjunction with heavy industry (Calumet Ecological Park Feasibility Study, NPS, 1998). In recent years, local, state, and federal agencies, as well as many private organizations, have focused tremendous effort in restoring water quality, floodwater functions, and recreational benefits to rivers and streams within the Calumet region including the Coffee Creek Watershed. This work includes studies on portions of the Coffee Creek watershed done by the Northwestern Indiana Regional Planning Commission and the *E. coli* Task Force. The Coffee Creek Watershed Conservancy is currently conducting studies on specific portions of the Coffee Creek watershed. The Coffee Creek Watershed Management Plan outlined in this Quality Assurance Plan will add an important piece to the restoration and management efforts currently underway in the larger Calumet Region.

Project Objectives

The goal of the project is to document the current physical, biological and chemical condition of the Coffee Creek watershed relative to the contributions of its tributary watersheds from which a watershed management plan can be developed. Data collected by the project will be use to make broad management decisions on a watershed scale. More specifically, data collected by the study will be used to identify "hot spots" in the watershed that may be contributing more nonpoint source pollutants to the creek relative to other areas of the watershed; to suggest appropriate Best Management Practices

(BMPs) to curb current ecological degradation in the watershed; and to guide future development in the watershed while maintaining its ecological health. As development occurs in the watershed, the data collected during this study will also serve as baseline data to track changes in the physical, biological and chemical conditions of the watershed due to development. Additionally, the data may be used as baseline data to track the success in any restoration project undertaken as a result of management plan.

The project goals will be accomplished by:

- Collecting historical data and documenting the current conditions of the watershed such as land use, soils (Highly Erodible Land), and stream and riparian habitat.
- Collecting and analyzing water quality and biological data
- Modeling non-point source pollutants in the watershed
- Assisting the community through watershed management plan development
- Documenting the community's goals, efforts, and action items in a written watershed management plan

Like all projects, limited financial resources and timeframes constrain this project. This study focuses on a watershed scale. Because of the size of the study area, the collection of detailed data at each sampling site will necessarily be sacrificed in order to collect broad data from the entire watershed. For example, family level identification of stream macroinvertebrates was selected as the level of data acceptable over species level identification. This will allow for the collection and identification of more samples for a given amount of time and money. Thus, more of the watershed may be surveyed providing a better indication of the watershed's ecological health. This loss in detailed data from specific sites is acceptable based on the overall goal of the project which is to measure the ecological health of the watershed relative to the tributary contributions in order to make broad management decisions.

To achieve the goal of evaluating and ranking hot spots in the watershed relative to one another and thus assisting the prioritization of management efforts, emphasis will be placed on maintaining standard procedures at each sampling station. All field personnel will be trained in the QHEI methods to ensure assessments will be as accurate as the method allows. Consistencies in protocol will ensure sampling stations can be compared to one another, enabling the principal investigator to determine which sites are most degraded relative to others in the watershed.

Only methods deemed acceptable by the larger scientific community will be used. For example, several researches have noted the acceptability of using family level identification to achieve rapid bioassessments of streams (Hilsenholf, 1988, USEPA, 1989, and IDEM, unpublished). In addition, because the study will adhere to standard protocols and procedures, comparisons to areas outside the Coffee Creek watershed may be possible when other studies utilize the same methods for data collection.

Project Site

The project site is the Coffee Creek watershed, including the creek and its tributaries, encompassing 16 square miles in north central Porter County (Figure 2). The project site is a subwatershed of the Little Calumet River Basin which lies within the Lake Michigan Basin (Eight digit watershed code: 04040001). Because the project's goal is to document the ecological conditions in the Coffee Creek watershed to guide management of the watershed, the study will examine/identify the following parameters:

1. Climate
2. Geology
3. Land use including wetlands
4. Topography
5. Significant natural areas
6. Locations of endangered and threatened species (ETR)
7. Soils
8. Water quality
9. Riparian/stream habitat quality
10. Biological (aquatic invertebrate) populations in the watershed

Parameters 1-7 are general parameters that will be examined on a watershed scale (i.e. no specific sampling sites). Much of this data has already been collected by several natural resources governmental agencies following specific protocols. The project will utilize this existing data rather than conducting field investigations for these parameters. This existing data has been collecting and verified in a manner sufficient to achieve the goals of this project (i.e. development of a watershed management plan).

Parameters 8-10 are site-specific parameters. Sampling sites were selected to achieve an accurate representation of the variety of stream habitat types found within the watershed. Preliminary site selection was based on map analysis. The map analysis consisted of locating tributaries with relatively large watersheds that also have access points (road crossings) near their confluences with the main stem of Coffee Creek. This approach was taken in an attempt to have sampling stations that may be able to indicate which subwatersheds are contributing the most pollutants to Coffee Creek. The sampling stations selected based on this map analysis were then field checked by the technical manager and the principal investigator for confirmation of site accessibility and appropriateness for the assessment protocols (mIBI and QHEI). Following the field inspection, eight sampling stations were selected. The locations of these sites are shown in Figure 3. Appendix A provides additional details on the site locations. Landowners at these sampling stations will be contacted to obtain permission to conduct sampling in those areas. Should permission be denied acceptable substitute stations will be selected using the same criteria outlined above. Any changes in sampling locations will be submitted as an addendum to this QAPP.

Water quality parameters to be sampled include as pH, temperature, conductivity, *E. coli*, dissolved oxygen, ammonia, nitrate, total Kjeldahl nitrogen, total phosphorous, and total suspended solids. PH, temperature, and dissolved oxygen will be analyzed in the field with field equipment. Discharge will be measured at each site to allow loading calculations and therefore comparison of relative contributions of the tributaries. Severn Trent Laboratories (STL) in Valparaiso, Indiana will analyze the remaining parameters at their lab. The aquatic macroinvertebrate community will be assessed using the Indiana Department of Environmental Management (IDEM) Rapid Bioassessment protocol (IDEM, Unpublished). Habitat quality will be assessed using Ohio Environmental Protection Agency (OEPA) Qualitative Habitat Evaluation Index (QHEI) protocol (OEPA, 1989). See Appendix B for QHEI protocol.

Sampling Design

General parameters collected at the watershed scale (Parameters 1-7 under Project Site) will be collected throughout the course of the study. Effort will be made to do the majority of this data collection in the initial stages of the project to allow for any adjustments in site-specific selection (water quality/biological riparian habitat sampling sites) as necessary. General parameters will be collected from sources that are required to follow specific and reviewed protocols such as state and federal natural resource agencies or peer reviewed scientific papers. Anecdotal data will be noted as such, if included at all in the data set.

Sampling station specific parameters (Parameters 8-10: macroinvertebrates, habitat, water quality) will be sampled periodically throughout the project period (Table 1). Biological and habitat sampling will occur twice during the project period, once during the spring and once during the fall. Biological sampling events will take place at the density and diversity peaks of aquatic macroinvertebrates (late May and October) to achieve representativeness of feeding guilds. Macroinvertebrates will be identified to family level to satisfy the project objective of surveying the entire watershed while staying within the project budget. As stated earlier, several researchers (Hilsenhoff, 1988, USEPA, 1989, and IDEM, Unpublished) have confirmed the appropriateness of using family level identification (vs. species level) to make broad scale management decisions as is the goal with this project.

Water quality samples will be collected four times throughout the study. Water quality sampling events will be timed to capture samples from base flow and peak flow (storm) events and non-growing season and growing season periods. This timing allows collection during the range of temporal and seasonal factors that may impact water quality. Again, the goal of the project is to collect data on a watershed scale from which broad management decisions can be made. Collection of water quality from this variety of situations will enable an overview of water quality in the watershed under varying conditions while staying within the project budget.

	Type of Sample/ Parameter	Number of Samples/Sampling Event/Sampling Station*	Sampling Event Frequency	Sampling Period
General Data	Land Uses, Soils, ETR, etc.	N/A	N/A	Spring/Summer 2001
Biological	Macroinvertebrate	1	2	October, 2001 May, 2002
Physical	Habitat	1	2	Fall, 2001 Spring, 2002
Chemical	Water Quality	1	4	Spring-Fall 2001, 2002

Table 1. Parameters studied

* Number does not include quality assurance samples/measurements taken to determine precision and accuracy.

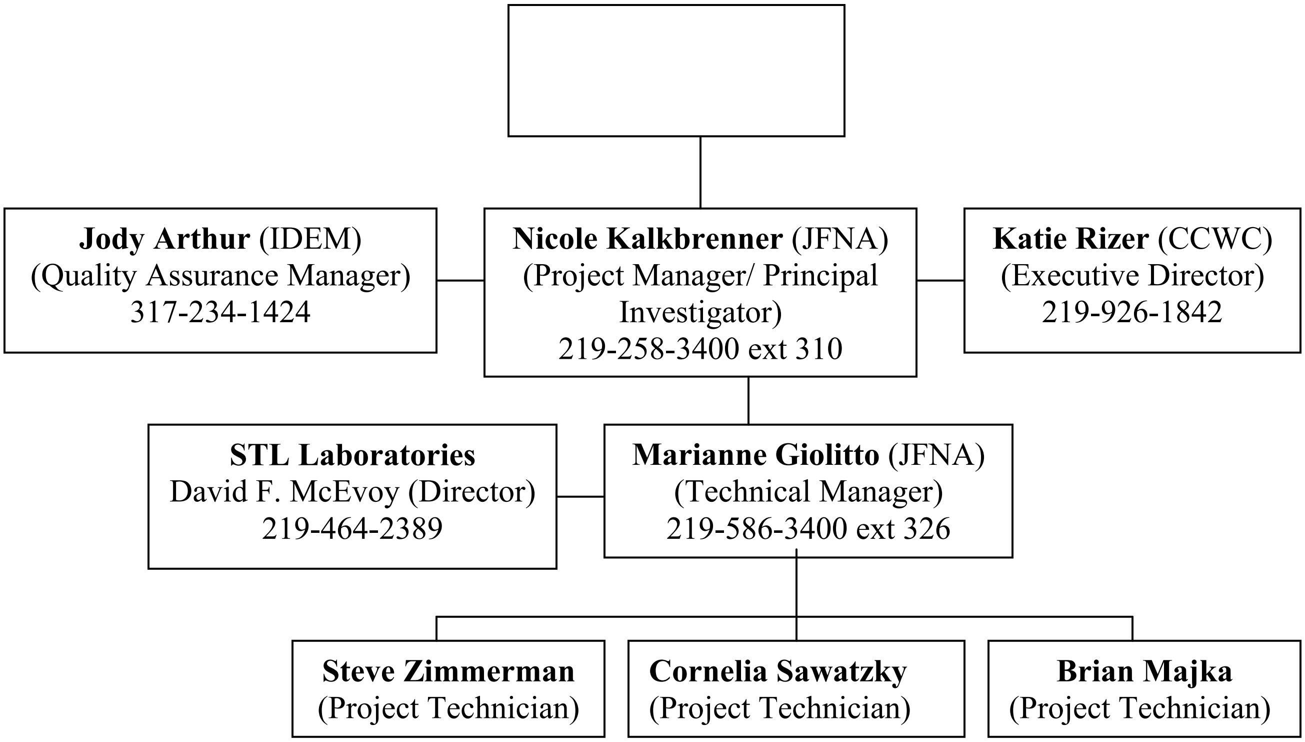
The water quality sampling schedule is flexible to prevent sampling during inappropriate weather or when equipment is not working.

Project Schedule

Project schedule is outlined in Table 1. The final project report will be submitted to the Coffee Creek Watershed Conservancy no later than February 28, 2003.

SECTION 2: PROJECT ORGANIZATION AND RESPONSIBILITY

In general, J.F. New & Associates will be responsible for the design, planning, execution, analysis and documentation of technical aspects of the project. J.F. New will also assist with coordination of public input and development of the watershed plan. The water-testing lab (STL Laboratories) will be responsible for chemical water quality analysis. The Coffee Creek Watershed Conservancy will be responsible for providing forums for public input and documenting the public's concerns and goals. Indiana Department of Environmental Management (IDEM) will provide the overall project guidance and assistance. Specific duties and responsibilities are outlined below.



Chain of authority

- Project Technicians report to Technical Manager
- Technical Manager coordinates with STL Laboratories
- Technical Manager reports to Project Manager/Principal Investigator.
- Project Manager/Principal Investigator coordinates with IDEM and CCWC
- Project Manager/Principal Investigator reports to Project Director

Duty list

- Location of sampling sites **(Project Manager and Technical Manager with oversight from Project Director)**
- Creation of QAPP **(Project Technician with oversight from Technical Manager)**
- Collection general parameters for watershed **(Project Technician with oversight from Technical Manager)**
- Collection of historical water quality data **(Project Technician with oversight from Technical Manager)**
- Water quality sampling **(Technical Manager, Project Technician with oversight from Project Manager)**
- Water quality sample analysis **(STL Laboratories)**
- Biological/habitat sampling **(Technical Manager, Project Technician with oversight from Project Manager)**
- Invertebrate identification **(Project Technician with oversight from Project Manager)**
- Modeling of non-point source pollution **(Technical Manager, Project Technician with oversight from Project Manager)**

- Monthly/quarterly updates **(CCWC based on input from Project Manager)**
- Final project report **(Project Manager, Technical Manager, Project Technician with oversight from Project Director)**
- Quality Assurance/Quality Control **(those listed above as providing oversight of specific duties are responsible for ensuring QA/QC of those specific duties; Project Director to oversee overall project QA/QC)**

SECTION 3: DATA QUALITY OBJECTIVES

Like any project, this project has financial and temporal constraints. The project goal is to document the current physical, biological, and chemical conditions of the watershed from which a watershed management plan can be developed. The project's data quality goals are based on this overall project goal. In general, this means that specificity will be sacrificed in order to obtain a greater quantity of general information representative of the entire watershed, not just a portion of it. For example, land use will be categorized on large-scale areas (1 ha units) rather than smaller areas (10×10 m areas). Collecting information on this larger scale will allow for the collection of more data for the same cost as the collection of a lesser quantity of data at a smaller scale. Similarly, family level identification will be used rather than species level of the macroinvertebrate communities. This will allow for the collection of more data per level of effort. Acceptable accuracy and precision limits will be decided by weighing the cost of achieving a specific level of accuracy/precision against the benefit obtained from having that data. Researchers have already confirmed the acceptable use of family level identification to make broad management decisions and prioritize areas for future specific work (USEPA, 1989; IDEM, Unpublished; Hilsenhoff, 1988). Based on this, the general data quality objectives are to gather representative information on the ecosystem's health at a watershed scale, collect broad, watershed scale data to make broad conclusions, and perform collection by accepted protocols to ensure the effort can be repeated in the future.

<u>General Parameters</u>
Because of time and financial constraints, existing data will be utilized rather than collecting original data for land use, soils, (Highly Erodible Land), natural area (ETR) locations and historical water quality measurements. Precision, accuracy and representativeness of these data will be ensured by only using data from local, state or federal agencies and peer or similarly reviewed publications. If anecdotal data is included in the plan, it will be noted as such. Due to the time frame available to collect this data and availability of the data, 100% completeness should be achieved. Because only data that was collected through a specific protocol (i.e. the Indiana Gap Analysis project protocol for land use) will be utilized by this project, the data can be compared to others efforts done using the same data collection protocol.

Water Quality Parameters

The contracted laboratory has implemented Quality Control/Quality Assurance (QA/QC) measures to ensure data quality (Appendix C). The laboratory standards are sufficient to meet the stated goals of this project.

Biological and Habitat Parameters

Accuracy and Precision

To ensure precision and accuracy, all sampling protocols will be carried out as required in the procedural documentation by qualified individuals. The same field team, consisting of a Project Technician and the Technical Manager, will sample each site using the same procedure to maintain consistency among sites. The consistency of field personnel and procedural organization will enhance precision by minimizing sampling variability.

Replicate field measurements will be taken with the following field equipment: the Hach Pocket Pal pH Meter, the YSI Model 51B, the Orion QuickChek Model 118, and the Global Water Flow Meter Model FP201. One replicate will be taken in every 10 measurements. Precision will be calculated using the Relative Percent Difference equation:

$$RPD = \frac{(C - C') \times 100\%}{(C + C')/2}$$

Where:
C = the larger of the two values
C' = the smaller of the two values

Macroinvertebrates will be identified by an experienced/trained Project Technician. At least 10% of the invertebrate specimens identified will be checked for identification accuracy. The Technician Manager will check the work. Any discrepancies between identification will be noted and discussed in order to obtain the correct identification through collaboration on the specific specimen in question. Photographic and, if possible, voucher specimens will serve as a benchmark for the purpose of checking the taxonomic accuracy of field identifications. This level of quality control will allow for making broad management decisions. Table 2 outlines the parameters, measurement range, accuracy and precision of both macroinverebrates and habitat evaluation.

Parameter	Method	Precision	Accuracy	Completeness
Macroinvertebrates	IDEM	High	High	75-100%
Habitat Analysis	OEPA QHEI	High	High	100%
PH	Hach Pocket Pal pH Meter	RPD<5%	± 0.1 at 20° C	75%
Temperature	YSI Model 51B	RPD<5%	± 2%	75%
Dissolved Oxygen	YSI Model 51B	RPD<5%	± 2%	75%
Conductivity	Orion QuickChek Model 118	RPD<5%	± 2%	75%
Flow	Global Water Flow Meter Model FP201	RPD<5%	± 0.05% at .5 ft/sec ± 0.02% at 1 ft/sec ± 0.03% at 5 ft/sec	75%
E. coli	Standard Methods 9213D	See Standard Methods Reference	See Standard Methods Reference	75%
Ammonia	EPA 350.1	See EPA Reference	See EPA Reference	75%
Nitrate	EPA 353.2	See EPA Reference	See EPA Reference	75%
Kjeldahl Nitrogen	EPA 351.2	See EPA Reference	See EPA Reference	75%
Total Phosphorous	EPA 365.2	See EPA Reference	See EPA Reference	75%
Total Suspended Solids	EPA 160.2	See EPA Reference	See EPA Reference	75%

Table 2. Data Quality Objectives for Field and Laboratory Methods.

Completeness

In the event that some catastrophic event (i.e. weather anomaly, chemical spill, or other event that would prohibit access to the creek) were to take place, the first action taken would be to delay the sampling to a later time that year, in hopes that access to the creek would be attainable during a more appropriate time. Since the sampling for biological parameters occurs at least once per year, there is flexibility built into the project schedule to allow sampling to occur during favorable conditions, preserving data quality. Because the project occurs over two years, during the first year sampling could be postponed until the following year in the event of some unforeseen catastrophic event.

Due to low flows in the headwaters, 100% collection of invertebrate and water quality samples may not be possible. Sampling locations have been field checked to prevent selection of a site where this may occur. However, climatic changes beyond the project's control may alter hydrology in the watershed, eliminating water flows in the headwaters (sites 7 and 8). If this occurs, only 75% completeness of water quality and invertebrate sampling may be achieved (see equation below). Efforts will be made to achieve 100% completeness. 75% completeness (absence of headwaters samples under extreme circumstances) will be acceptable for completion of the project.

$$\%\ \text{completeness} = \frac{(\text{number of valid measurements}) \times 100\%}{(\text{number of valid measurements expected})} = \frac{12 \times 100\%}{16} = 75\%$$

Representativeness
Representativeness is the most important data quality metric in the project since the project objective is to provide watershed scale data. Representativeness of sampling sites was achieved by performing a desktop review of potential sampling sites. Because the number of tributaries to the main stem of Coffee Creek exceeds the number of sites that can be sampled by this project given the limited resources, not all tributaries could be sampled. The following criteria were used to narrow the set of potential sites. Accessibility (proximity to a road) and location in the watershed (ensuring that tributaries and main stem are sampled) were the two criteria used in the desktop review to select potential sites. Potential sites were then field checked by the Principal Investigator and Technical Manager to ensure accessibility and the variety of physical, riparian, and in-stream habitats in the watershed were all represented in the set of sampling stations. Landowner permission will confirm potential sites usability as sampling sites. Additional criteria for choosing sites is whether it has been used in historical studies to which this project's data may be compared.

Comparability
The biological and habitat samples are expected to be comparable because the project will follow biological sampling and habitat assessment procedures set forth by IDEM's Rapid Bioassessment protocol for macroinvertebrates, using the macroinvertebrate Index of Biotic Integrity (IDEM, unpublished) and OEPA's Quality Habitat Evaluation Index (QHEI) (Appendix B). Results of this study can be compared to other studies using these protocols.

SECTION 4: SAMPLING PROCEDURES
The sampling methods and equipment are summarized in Table 3.

Macroinvertebrate Sampling
Methods for sampling macroinvertebrates will follow standard methods established by IDEM's Rapid Bioassessment protocol. Two samples using a 1 × 1 meter, 600 μm kick net will be performed at each of the sample stations. Organisms collected in the net will be placed in clean, wide-mouth plastic collection jugs containing 70-80% alcohol for identification and stored on ice. Identification will take place within 1 week of collection (Appendix C - data sheets 1 and 2). Since the water is no more than chest deep at any one site, each site lends itself to the use of a kick net. After collection of invertebrate samples, samples will be stored on ice. Invertebrate samples will be transported on ice to the J.F. New & Associates laboratory immediately following collection of the samples. Invertebrate samples will be identified and checked within one week of collection to limit any potential deterioration of the identifying features of the organisms. During the identification and confirmation time period, invertebrate samples will be stored on ice or in a refrigerated cooler.

Water Quality Sampling
Water quality samples will be taken at each station to test the parameters listed in Table 4. PH, dissolved oxygen, temperature, and water velocity measurements will be made in the field using the following instruments: Hach pH meter, YSI Model 51B D.O. meter,

Global Water flow meter. All measurements will be taken according to the standard operating procedures provided by the manufacturer of the equipment. Grab samples will be collected for the remaining water quality parameters. Samples will be placed in plastic containers supplied by STL Laboratories in Valparaiso, Indiana. STL Laboratories will provide the appropriate preservatives in the pre-packaged in the containers as necessary. Samples will be taken using standard protocol and stored on ice, then taken to the lab by the Project Technician. After collection of water quality samples, samples will be stored on ice. Water quality samples will be transported immediately to the lab. Required chain of custody procedures as outlined in the laboratory's QA/QC plan (Appendix C) will be followed. Water quality samples will be processed at the lab using standard operating protocol (see Appendix C). Analytical results from the water quality lab will be based on their schedule but are anticipated within 2-3 weeks of sample collection.

QHEI Analysis
Habitat evaluation will be conducted at each station using Ohio EPA's Quality Habitat Evaluation Index (QHEI). The field crew will adhere to OEPA QHEI standard procedures. Assessments will be made by the field crew and noted on QHEI data sheets (Appendix D, data sheet 1).

Parameter	**Sampling Equipment**	**Sampling Method**
Macroinvertebrates	storage bottles, forceps, cooler, ice 1 × 1 meter, 600 μm kick net	IDEM's Rapid Bioassessment Protocol
Habitat	N/A	OEPA's QHEI Protocol
Water Quality Collection	plastic bottles, DO meter, pH meter, cooler, ice, flow measurement, tape measure	See lab protocol for specifics on each parameter analyzed

Table 3. Sampling methods

SECTION 5: CUSTODY PROCEDURES

The field crew consisting of the Project Technician and Technical Manager will use IDEM's Rapid Bioassessment protocol to collect macroinvertebrates samples. All invertebrates removed from the sites will be placed in wide-mouth plastic containers with a preservative and labeled with the sample location, sample number, date and time of collection, sample parameter, and sampler(s) name(s). Sample bottles will be stored on ice. Samples will be transported to the J.F. New laboratory and stored in a cooler until identification is completed. Identification will be completed within one week of sampling. Identifications will be made by a Project Technician and checked for precision and accuracy by the Technician Manager using the following taxonomic references: Eddy and Hodson (1982), Merritt and Cummins (1996), and Eckblad (1978). Appendix D contains the data sheet to be used for macroinvertebrate identification.

The field crew will take water quality samples using the laboratory protocol. Samples will be labeled with the sample location, sample number, date and time of collection, sample parameters, and sampler name(s). Samples will be stored on ice and transported on the same day to STL Laboratories. The report from STL Laboratories is expected within three weeks of sampling.

The field crew will take QHEI measurements using OEPA protocols. Measurements will be noted on the QHEI data sheet located in Appendix D. Samples are not collected as part of this procedure.

SECTION 6: CALIBRATION PROCEDURES AND FREQUENCY

Calibration measures will be performed on all field equipment to be used (where appropriate) based upon the manufacturers recommendations as spelled out in the users manual for each individual piece of equipment. Calibration will be performed the day of each sampling prior to use of the equipment in the field. See Appendix C for STL laboratory calibration procedures and frequencies.

SECTION 7: ANALYTICAL PROCEDURES

All procedures that will be used to analyze the macroinvertebrate samples and QHEI assessments will strictly adhere to the IDEM Rapid Bioassessment protocol or the OEPA QHEI protocol respectively. Because these tools were designed to make rapid assessments at large scales, the use of these tools will enable the achievement of project goals. In general, detection limits are not applicable to the biological and physical habitat assessment used in this project. Small organisms (smaller than 600 μm) however, may not be collected due to mesh size of the sampling net. Similarly, the field picker may overlook small organisms caught in the net. Nets will be double checked to prevent this. Table 5 provides an overview of the analytical procedures. Appendix C details the analytical procedures STL Laboratories utilize for chemical water quality assessments.

Matrix	Parameter	Method	Detection Limits	Holding Time
substrate	macroinvertebrates	IDEM	N/A	6 weeks
habitat	habitat analysis	OEPA QHEI	N/A	N/A
water	pH	Hach pH meter	0.1	N/A
water	temperature	YSI Model 51B	1 degree C	N/A
water	dissolved oxygen	YSI Model 51B	0.1mg/l	N/A
water	conductivity	QuicKcheK Model 118	10.0	NA
water	*E. coli*	Standard Methods 9213D	N/A	24 hours
water	ammonia	EPA 350.1	0.01mg/l	28 days
water	nitrate	EPA 353.2	0.05mg/l	48 hours
water	Kjeldahl nitrogen	EPA 351.2	0.50mg/l	28 days
water	total phosphorus	EPA 365.3	0.10mg/l	28 days
water	total suspended solids	EPA 160.2	1.0mg/l	7 days
water	flow	Global Water Flow Meter Model FP201	0.1	N/A

Table 4. Analytical procedures

SECTION 8: QUALITY CONTROL PROCEDURES

In summary, quality control will be achieved by strict adherence to written protocol. Quality control in the field will be obtained by adherence to standard operation protocols. Independent QHEI assessments will be made by each member of the field crew to ensure precision and accuracy of habitat assessment. Any differences in assessments will be averaged if possible based on the metric. Where averaging of a metric is not possible, the value given by the Technical Manager will be accepted. Fieldwork will be performed by the same crew at each site. The Technical Manager will ensure consistency in sample collection and field work. Quality control of macroinvertebrate identification will be achieved by having a single initial identifier of each sample with 10% of each sample being checked by the Technical Manager. Inaccuracies greater than 25% of the checked portion will trigger reevaluation of the entire sample unless deemed unnecessary. (For example, technician is consistently misidentifying one family; in that case, only the individuals of that family will be reevaluated.) Consistency in protocol will allow for comparisons to be made among sample sites and thus achieve the project goals of identifying hot spots within the watershed for more targeted intensive management.

Quality control of lab water quality analysis will be performed as outlined in the lab's QA/QC plan. This quality control includes use of lab duplicates, split samples, reference standards and method blanks where appropriate. This level of quality control is sufficient to achieve project goals.

SECTION 9: DATA REDUCTION, REVIEW, AND REPORTING

Field sheets will be given to the Technical Manager at the end of the sampling day for review. Field data sheets will be inspected for completeness and signed by the Technical Manager before leaving the site. Within 72 hours, the Technical Manager will contact any samplers whose field sheets contain significant errors. Data from the field data sheets and invertebrate identification data sheets will be used to calculate both a (mIBI) and QHEI to indicate the biological integrity or habitat quality of the aquatic system at the specific sites studied. The Technical Manager will review macroinvertebrate identification.

Water samples given to STL laboratories will contain data sheets similar to the one shown in Appendix E. This data sheet will be filled out by the Technical Manager and hand delivered along with the samples to STL Laboratories in Valparaiso, Indiana. STL Laboratories will review sample labels and remove from the data set any that cannot be attributed to specific samplers, have not been properly preserved, or that exceed the maximum holding time. The laboratory manager will also sign-off on lab bench sheets after all checks have been completed. Complete data reduction review and reporting of water quality data done by the lab is detailed in Appendix C.

All data will be entered into a computerized spreadsheet/data base program designed for this project and compatible with hardware and software used by J.F. New & Associates, IDEM, and the CCWC.

The final report will be produced and distributed no later than February 28, 2003. The Project Manager will be responsible for report production and distribution. Assistance in these tasks will be provided by the Technical Manager and the Project Technicians. The Project Director will conduct the final review of the report. The report will contain the data results, interpretation of the data, Best Management proposals for existing watershed conditions, a compilation of watershed stakeholders' concerns and goals, and proposals for future development in the watershed.

SECTION 10: PERFORMANCE AND SYSTEM AUDITS

While specific audits such as those conducted on the contracting laboratory by outside auditors are not applicable to this type of project, the following checks and balances and a oversight will be utilized to ensure data quality:

- The Technical Manager will provide oversight to all technical staff ensuring strict adherence to all protocols.
- Field data sheets will be reviewed for completeness prior to leaving the field.
- QHEI assessments will be made by two individuals.

STL Laboratories has built in audits. The Project staff is open to IDEM's audits upon IDEM's request.

SECTION 11: PREVENTIVE MAINTENANCE

A kick net, conductivity meter (QuicKcheck Model 118), thermometer (YSI Model 51B), tape measure, flowmeter (Global Systems), yardstick and dissolved oxygen meter (YSI Model 51B) will all be used for macroinvertebrate and water quality sampling by J.F. New & Associates, Inc. To keep these instruments in proper working order, all maintenance will be performed as outlined in the users manuals that are provided with the equipment where appropriate.

SECTION 12: DATA QUALITY ASSESSMENT

As stated in the Project Objectives portion of **SECTION 1**, the goal of the project is to document the current physical, biological and chemical condition of the Coffee Creek relative to the contributions of its tributary watersheds. Data collected by the study will be used to identify "hot spots" in the watershed that may be contributing more nonpoint source pollutants to the creek relative to other areas of the watershed. Data quality controls outlined in the Sections above will be sufficient to meet the objectives of the project. Data quality assessments taken by the contracting laboratory will be sufficient to meet the objectives of the project (see Appendix C).

In addition, the project has built into it several measures to provide continuous review of data to ensure completeness and modify the project if necessary. For example, the Technical Manager will review field sheets before leaving the site to check for completeness. See above Sections for details on other built in reviews to ensure completeness.

Due to the flexibility in scheduling of sampling events, 75-100% completeness is anticipated. If for some reason (such as ones outlined in previous sections) 100% collection of samples is not possible, the data will be evaluated to determine whether the watershed has been sufficiently represented in the data collected to date. Meeting the goal of representation is of primary importance since it is one of the study's data objectives. Data will be evaluated for representativeness based primarily on the three following criteria: all sampling stations have been sampled at least once, have samples been taken during both storm and base flow events, and has there been one fall and one spring sampling. Those criteria are listed in order of importance. The first one listed will have more importance than the following two in deciding whether the project is complete despite not collecting 100% of the samples. Any decisions to deem the project complete without 100% collection of data will be made by the Project Director with input from the Project Manager and the Technical Manager. The IDEM Project Manager will be included in all such decisions.

SECTION 13: CORRECTIVE ACTION

Should extraordinary events occur that may adversely affect the collection of accurate, representative data (extreme climatic conditions, chemical spill, etc.), testing shall be rescheduled during the same year when conditions are more favorable. The data can then be analyzed so that reports can be written. Since sampling is done only once (invertebrates and habitat) or twice per year (water quality) for each parameter studied, it is feasible to schedule another sampling trip at a time when conditions permit within the same year. If, for reasons beyond the project's control, samples cannot be collected during a sampling year, the prohibitive conditions will be noted, and all efforts shall be made to perform a similar testing operation the following year.

STL Laboratory corrective actions that will be taken for the chemical water quality analysis are noted in Appendix C. Less than 75% accuracy of checked 10% of macroinvertebrate sample will trigger corrective actions for the invertebrate identification. Such corrective actions could include discussion with sampler and identifier to determine the source of error, re-identification of part of or the entire sample, and/or discarding an unusable sample where appropriate. Any habitat data collected according to standard operating protocols will meet the data collection objectives. Corrective actions are not applicable to this form of assessment.

SECTION 14: QUALITY ASSURANCE REPORTS

Quarterly reports will be written and submitted starting in July 2001 and ending in January 2003 for a total of seven progress reports. Any problems that are found with the data will be documented in the quarterly reports. Quality assurance issues that may be addressed in the quarterly reports include, but are not limited to the following:

- Assessment of such items as data accuracy and completeness
- Results of performance and/or system audits
- Significant QA/QC problems and recommended solutions
- Discussion of whether the QA objectives were met and the resulting impact on decision making
- Limitations on use of the measurement data

If no QA/QC problems arise, this will be noted in the report.

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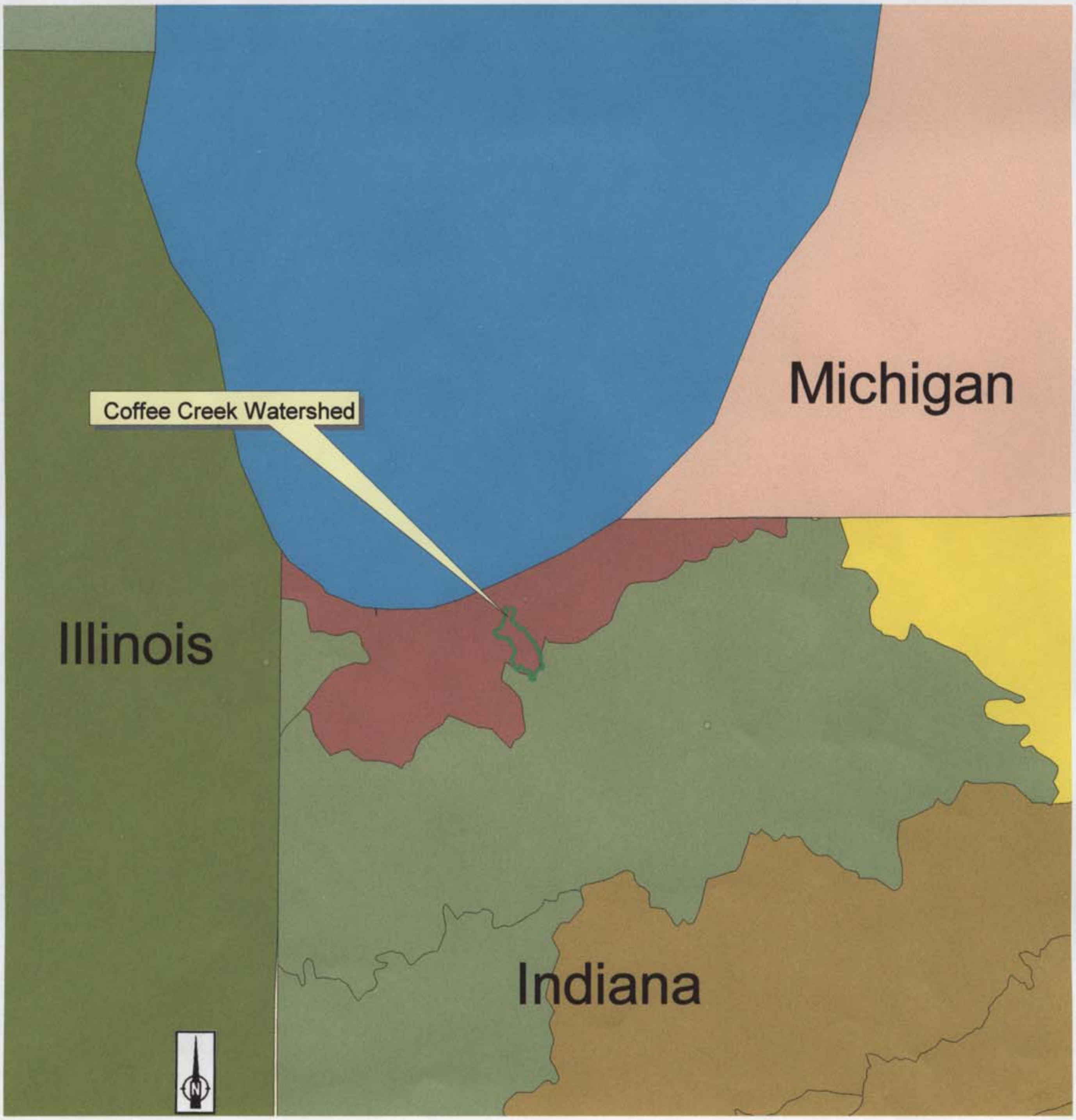

Figure 1
Vicinity Map

J.F. New & Associates, Inc.
708 Roosevelt Road
P.O. Box 243
Walkerton, IN 46574
Phone: 219-586-3400
FAX: 219-586-3446
Permitting • Delineations • Mitigation Design • Biological Inventories
Wetland and Prairie Nursery • Lake and Stream Enhancement
Natural Systems for Wastewater Treatment

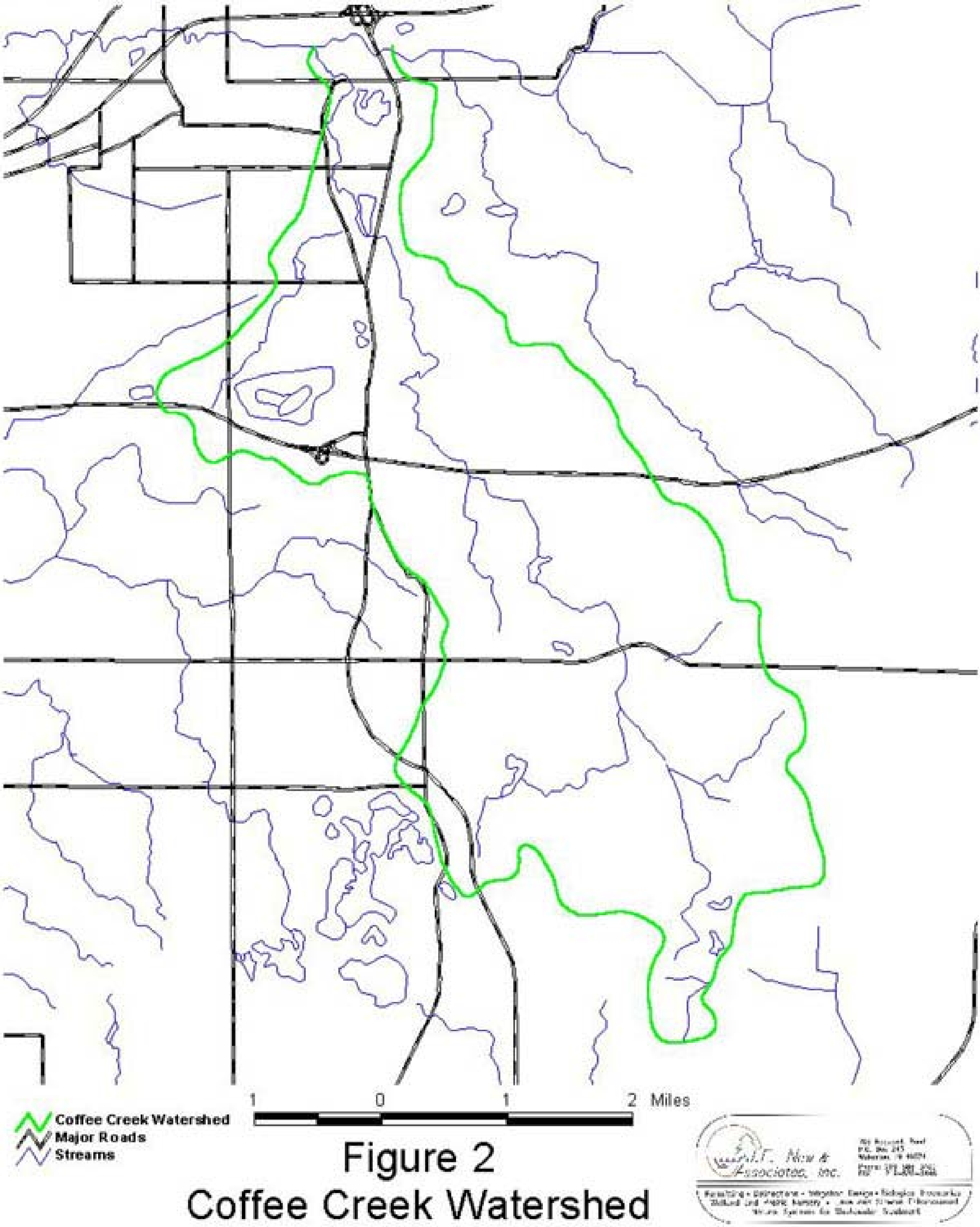

Figure 2
Coffee Creek Watershed

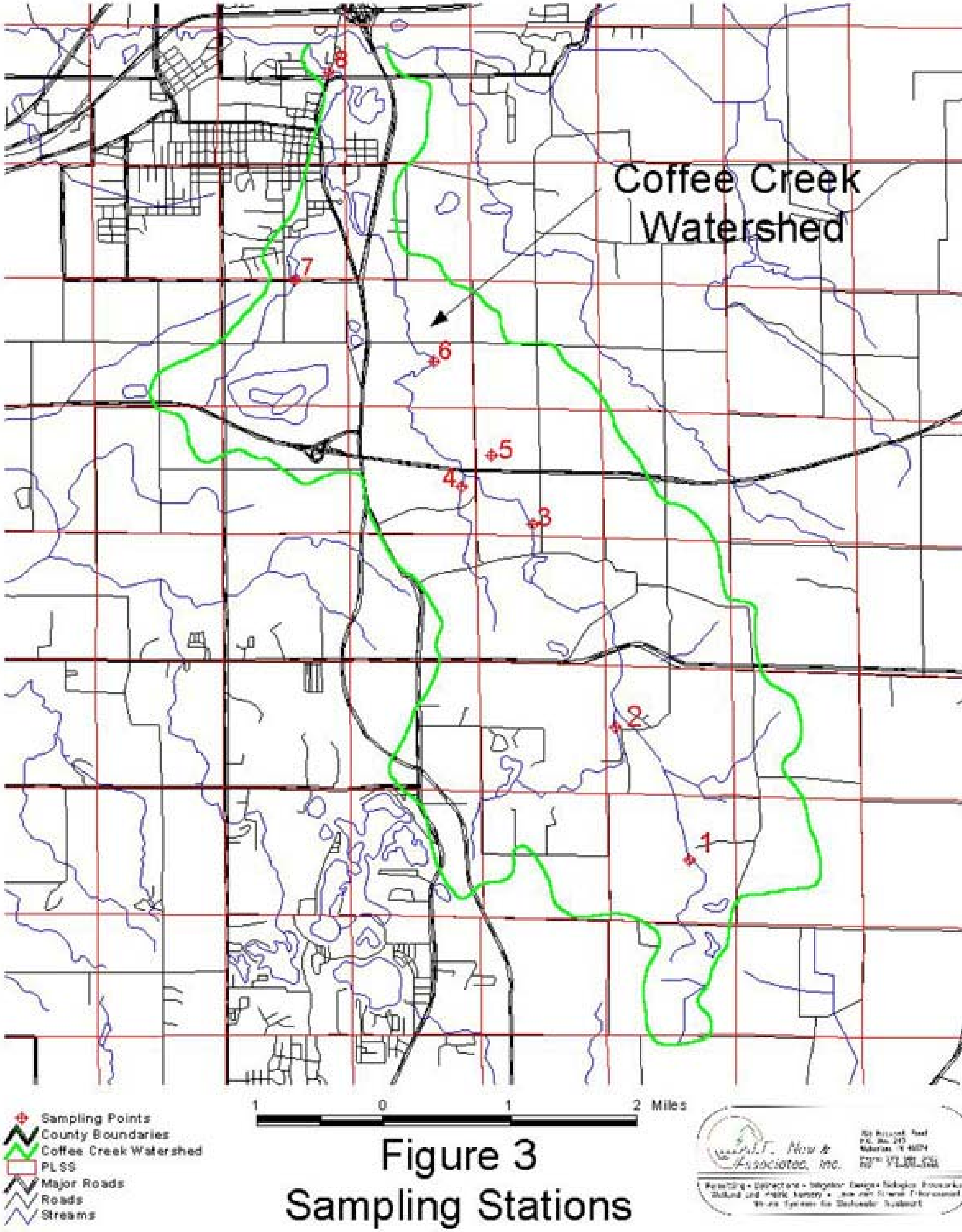

Figure 3
Sampling Stations

APPENDIX A

SAMPLING STATION LOCATIONS

PROPOSED SAMPLING LOCATIONS

Site 1

Site 1 is located along Old State Road 49 (Calumet Road) immediately north of Indian Boundary Line Road where Old State Road 49 crosses Coffee Creek. The sampling station lies approximately 2000' upstream of the confluence of Coffee Creek with the Little Calumet River. Low grassy banks border Coffee Creek on the east side of Calumet Road. Sand is the dominant substrate type at this point. Sampling is proposed on the east side of the Old State Road 49 bridge as it offers the best access point.

Site 2

Site 2 covers the Pope O'Connor Ditch, the largest tributary to Coffee Creek. The proposed site is located on the north side of County Road 1100 North approximately 500' east of 5th Street. P. O'Connor Ditch is bordered by low grassy banks and possesses a silty substrate at the proposed sampling location. Field inspection of the entire ditch indicated that this is the most suitable site for sampling, meeting both the representativeness and accessibility criteria.

Site 3

Site 3 lies within the Coffee Creek Center development. The site meets the selection criteria in that it is accessible; permission to access the site has been granted by the property owner; and it is representative of the restored portions of the creek. The eastern creek bank was reshaped to form a gentle (greater than 5:1) slope during the restoration work at this site. The eastern bank was also seeded with a variety of native grasses and forbs. The west bank was not altered during restoration work. The west bank is low and vegetated with both herbaceous and woody species. The creek substrate at this site consists of large gravel/small cobble. This site has also been monitored as a part of other projects, providing baseline data for comparison. The site is located approximately 1200' feet upstream of County Road 1050 North.

Site 4

Site 4 is located on Shooter Ditch east of County Road 200 East and north of the 80/90 Interstate. Shooter Ditch is one of the larger tributaries to Coffee Creek. Because the proposed sampling site lies within the Coffee Creek Center development, permission to access the site has already been granted. The site is also easily accessible. The land immediately around the ditch consists of fallow agricultural land. This land was recently removed from agricultural production with farming occurring within the past decade. The straight box-shaped channel morphology provide evidence of recent farming efforts. In an attempt to improve drainage, many agricultural landowners continually straighten and dredge adjacent ditches, altering the ditches' natural morphology. Shooter Ditch possesses a silty substrate. Its banks are vegetated with upland grasses. These characteristics are typical of agricultural ditches in the watershed.

Site 5

Site 5 covers Johnson Ditch, another large tributary to Coffee Creek. The proposed site is located along a dead end gravel road, immediately west of County Road 200 East and south of the 80/90 Interstate. The site meets the accessibility criterion; landowner permission has not yet been obtained. Exact location (i.e. which side of the gravel road) to be sampled will be based on ability to obtain landowner permission. Johnson Ditch differs from Shooter Ditch in that much low-density residential land surrounds the channel. The channel is straight and narrow, suggesting an agricultural origin. However, its grassy (turf grass) banks are lower than Shooter's banks and its substrate consists of small to medium sized gravel. This riparian habitat is representative of typical low-density residential areas in the watershed.

Site 6

Site 6, like Site 3, represents the central portion of Coffee Creek. The proposed site is located downstream of Old Longs Mill or west of County Road 250 East and north of Tratebas Road. The site meets the accessibility criterion; landowner permission has not yet been obtained. Exact location to be sampled will be based on ability to obtain landowner permission. Coffee Creek flows through undisturbed woodlots in this area. The creek banks are somewhat steeper and more eroded compared to the riparian habitat at Site 3. Medium to large sized gravel dominates the substrates. Canopy cover ranges between 50 and 75 % making it representative of wooded portions of the creek corridor.

Site 7

Site 7 covers a large unnamed tributary in Coffee Creek's headwaters. The unnamed tributary flows north and east through Moraine Nature Preserve and a low-density residential area before joining Coffee Creek. The proposed sampling station is located near a 90-degree bend in Suman Road. The site meets the accessibility criterion; landowner permission has not yet been obtained. Exact location to be sampled will be based on ability to obtain landowner permission. The proposed site possesses low grassy banks and a sandy substrate. The mix of protected areas (Moraine Nature Preserve) and low-density residential land use is typical of the upper watershed.

Site 8

Site 8 represents the headwaters of Coffee Creek. The site was selected as the highest possible point in the creek that would still maintain a flow during normal summer weather. The creek and its tributaries are likely intermittent in nature above this point. The site is located within the St. Andrews residential development. The site meets the accessibility criterion; landowner permission has not yet been obtained. Exact location to be sampled will be based on ability to obtain landowner permission. The proposed site possesses low wooded banks and a gravel/small cobble substrate. Some bank erosion was noted, likely the result of variable flows in the headwaters stream. Stream gradient is steeper here compared to areas lower in the watershed. This is to be expected in the headwaters of the watershed. Thus the sampling site provides representation of the steeper portions of the creek and of the watershed's headwaters.

APPENDIX B

QHEI PROTOCOL

ieographical Information

1) *Stream, River Mile (RM), Date* – The official stream name may be found in the Gazetteer of Ohio Streams Ohio DNR, 1960) or on USGS 7.5 minute topographic naps. If the stream is unnamed, a name and stream code is assigned by the *Surface Water Section Database Coordinator*. Usually the name of a nearby andmark is used for the stream name. A basin-river code is also assigned from the FINS river code system. The River Mile (RM) designations used are found on 7.5 minute topo maps stored at the Ohio EPA, Office of Planning, 1800 WaterMark Drive (PEMSO RMI maps), ne of five Ohio EPA District offices (maps for that istrict), and Ohio EPA, Division of Water Quality Monitoring Assessment laboratory at 1030 King Avenue.

2) Specific Location

A brief description of the sampling location should nclude proximity to a local landmark such as a bridge, oad, discharge outfall, railroad crossing, park, tributary, am, etc.

Field Sampling Crew

The field crew involved with the sampling is noted on ie sheet with the person who filled out the sheet listed rst. QHEI information is to be completed by the crew ader *only*.

*) Habitat Characteristics: **QHEI** Metrics*

he **Qualitative Habitat Evaluation Index** **QHEI)** is a physical habitat index designed to provide empirical, quantified evaluation of the general lotic *acrohabitat* characteristics that are important to fish ommunities. A detailed analysis of the development nd use of the QHEI is available in Rankin (1989). The HEI is composed of six principal metrics each of hich are described below. The maximum possible **QHEI** site score is 100. Each of the metrics are scored individually and then summed to provide the total **QHEI** site score. This is completed at least once for each sampling site during each year of sampling. An exception to this convention would be when substantial changes to the macrohabitat have occurred between sampling passes.Standardized definitions for pool, run, and riffle habitats, for which a variety of existing definitions and perceptions exist, are essential for accurately using the **QHEI**. For consistency the following definitions are taken from Platts *et al.* (1983). It is recommended that this reference also be consulted prior to scoring individual sites.

Riffle and Run Habitats:

Riffle - areas of the stream with fast current velocity and shallow depth; the water surface is visibly broken.

Run - areas of the stream that have a rapid, non-turbulent flow; runs are deeper than riffles with a faster current velocity than pools and are generally located downstream from riffles where the stream narrows; the stream bed is often flat beneath a run and the water surface is not visibly broken.

Pool and Glide Habitats:

Pool[5] - an area of the stream with slow current velocity and a depth greater than riffle and run areas; the stream bed is often concave and stream width frequently is the greatest; the water surface slope is nearly zero.

Glide - this is an area common to most modified stream channels that do not have distinguishable pool, run, and riffle habitats; the current and flow is similar to that of a canal; the water surface gradient is nearly zero.

The following is a description of each of the six QHEI

[5] If a pool or glide has a maximum depth of less than 20 cm, it is deemed to have lost its functionality and the metric is scored a 0.

metrics and the individual metric components. Guidelines on how to score each is presented. Generally, metrics are scored by checking boxes. In certain cases the biologist completing the **QHEI** sheet may interpret a habitat characteristic as being intermediate between the possible choices; in cases where this is allowed (denoted by the term **"Double-Checking"**) two boxes may be checked and their scores averaged.

Metric 1: Substrate

This metric includes two components, *substrate type* and *substrate quality*.

Substrate type

Check the two most common substrate types in the stream reach. If one substrate type predominates (greater than approximately 75-80% of the bottom area *OR* what is clearly the most *functionally* predominant substrate) then this substrate type should be checked twice. **DO NOT CHECK MORE THAN TWO BOXES**. *Note the category for artificial substrates.* Spaces are provided to note the presence (by check marks, or estimates of % if time allows) of *all* substrate types present in pools and riffles that each comprise at least 5% of the site (*i.e.*, they occur in sufficient quantity to support species that may commonly be associated with the habitat type). This section must be filled out completely to permit future analyses of this metric. If there are more than four substrate types in the zone that are present in greater than approximately 5% of the sampling area check the appropriate box.

Substrate quality

Substrate *origin* refers to the "parent" material that the stream substrate is derived from. Check **ONE** box under the substrate origin column *unless* the parent material is from multiple sources (*e.g.*, limestone and tills). **Embeddedness** is the degree that cobble, gravel, and boulder substrates are surrounded, impacted in, or covered by fine materials (sand and silt). Substrates should be considered embedded if >50% of surface of the substrates are embedded in fine material. Embedded substrates cannot be easily dislodged. This also includes substrates that are concreted or "armour-plated". Naturally sandy streams are not considered embedded; however, a sand predominated stream that is the result of anthropogenic activities that have buried the natural coarse substrates is considered embedded. Boxes are checked for *extensiveness* (area of sampling zone) of the embedded substrates as follows: **Extensive** — > 75% of site area, **Moderate** — 50-75%, **Sparse** — 25-50%, **Low** — < 25%.

Silt Cover is the extent that substrates are covered by a silt layer (*i.e.*, more than 1 inch thickness). **Silt Heavy** means that nearly all of the stream bottom is layered with a deep covering of silt. **Moderate** includes extensive coverings of silts, but with some areas of cleaner substrate (*e.g.*, riffles). **Normal** silt cover includes areas where silt is deposited in small amounts along the stream margin *or* is present as a "dusting" that appears to have little functional significance. If substrates are exceptionally clean the **Silt Free** box should be checked.

Substrate types are defined as:

a) *Bedrock* - solid rock forming a continuous surface.

b) *Boulder* - rounded stones over 256 mm in diameter(10 in.) or large "slabs" more than 256 mm in length (*Boulder slabs*).

c) *Cobble* - stones from 64-256 mm (2 1/2 - 10in.) in diameter.

d) *Gravel* - mixture of rounded course material from 2-64 mm (1/12 - 2 1/2 in.) in diameter.

e) *Sand* - materials 0.06 - 2.0 mm in diameter, gritty texture when rubbed between fingers.

f) *Silt* - 0.004 - 0.06 mm in diameter, generally this is fine material which feels "greasy" when rubbed between fingers.

g) *Hardpan* - particles less than 0.004 mm in diameter, usually clay, which forms a dense, gummy surface that is difficult to penetrate.

h) *Marl* - calcium carbonate; usually greyish-white; often contains fragments of mollusc shells.

i) *Detritus* - dead, unconsolidated organic material covering the bottom which could include sticks, wood and other partially or undecayed coarse plant material.

j) *Muck* - black, fine, flocculent, completely decomposed organic matter (*does not include* sewage sludge).

k) *Artificial* - substrates such as rock baskets, gabions, bricks, trash, concrete etc., placed in the stream for reasons *OTHER* than habitat mitigation

Sludge is defined as a thick layer of organic matter, that is decidedly of human or animal origin. **NOTE: SLUDGE THAT ORIGINATES FROM POINT SOURCES IS NOT INCLUDED; THE SUBSTRATE SCORE IS BASED ON THE UNDERLYING MATERIAL.**

Substrate Metric Score:

Although the theoretical maximum metric score is > 20 the maximum score allowed for the **QHEI** is limited to **20 points**.

Metric 2: Instream Cover

This metric consists of *instream cover type* and *instream cover amount*. All of the cover types that are present in greater than approximately 5% of the sampling area (i.e., they occur in sufficient quantity to support species that may commonly be associated with the habitat type) should be checked. Cover should not be counted when it is in areas of the stream with insufficient depth (usually < 20 cm) to make it useful. For example a logjam in 5 cm of water contributes very little if any cover, and at low flow may be dry. Other cover types with limited utility in shallow water include *undercut banks* and *overhanging vegetation*, *boulders*, and *rootwads*. Under *amount*, one or two boxes may be checked. *Extensive* cover is that which is present throughout the sampling area, generally greater than about 75% of the stream reach. Cover is *moderate* when it occurs over 25-75% of the sampling area. Cover is *sparse* when it is present in less than 25% of the stream margins (sparse cover usually exists in one or more isolated patches). Cover is *nearly absent* when no large patch of any type of cover exists anywhere in the sampling area. This situation is usually found in recently channelized streams or other highly modified reaches (*e.g.* ship channels). If cover is thought to be intermediate in amount between two categories, *check two boxes and average their scores*. Cover types include: 1) undercut banks, 2) overhanging vegetation, 3) shallows (in slow water), 4) logs or woody debris, 5) deep pools (> 70 cm), 6) oxbows, 7) boulders, 8) aquatic macrophytes, and 9) rootwads (tree roots that extend into stream). Do not check undercut banks AND rootwads unless undercut banks exist *along with* rootwads as a major component.

Cover Metric Score:

Although the theoretical maximum score is > 20 the maximum score assigned for the QHEI for the instream cover metric is limited to **20 points**

Metric 3: Channel Morphology

This metric emphasizes the quality of the stream channel that relates to the creation and stability of macrohabitat. It includes channel sinuosity (*i.e.* the degree to which the stream meanders), channel development, channelization, and channel stability. One box under each should be checked unless conditions are considered to be intermediate between two categories; in these cases *check two boxes and* ***average*** *their scores.*

a) *Sinuosity* - **No** sinuosity is a straight channel. **Low** sinuosity is a channel with only 1 or 2 poorly defined outside bends in a sampling reach, or perhaps slight meandering within modified banks. **Moderate** sinuosity is more than 2 outside bends, with at least one bend well defined. **High** sinuosity is more than 2 or 3 well defined outside bends with deep areas outside and shallow areas inside. Sinuosity may be more conceptually described by the ratio of the stream distance between two points on the channel of a stream and the straight-line distance between these same two points, taken from a topographic map. Check *only* one box.

b) *Development* - This refers to the development of riffle/pool complexes. **Poor** means *riffles* are absent, or if present, shallow with sand and fine gravel substrates; *pools*, if present are shallow. Glide habitats, if predominant, receive a **Poor** rating. **Fair** means riffles are poorly developed or absent; however, pools are more developed with greater variation in depth. **Good** means better defined riffles present with larger substrates (gravel, rubble or boulder); pools have variation in depth and there is a distinct transition between pools and riffles. **Excellent** means development is similar to the Good category except the following characteristics must be present: pools must have a maximum depth of >1m and deep riffles and runs (>0.5m) must also be present. In streams sampled with wading methods, a sequence of riffles, runs, and pools must occur more than once in a sampling zone. Check *one* box.

c) *Channelization* - This refers to anthropogenic channel modifications. **Recovered** refers to streams that have been channelized in the past, but which have recovered most of their natural channel characteristics. **Recovering** refers to channelized streams which are still in the process of regaining their former, natural characteristics; however, these habitats are still degraded. This category also applies to those streams, especially in the Huron/Erie Lake Plain ecoregion (NW Ohio), that were channelized long ago and have a riparian border of mature trees, but still have **Poor** channel characteristics. **Recent** or **No Recovery** refers to streams that were recently channelized or those that show no significant recovery of habitats (*e.g.* drainage ditches, grass lined or rock rip-rap banks, etc.). The specific type of habitat modification is checked in the last two columns but not scored.

d) *Stability* - This refers to channel stability. Artificially stable (concrete) stream channels receive a **High** score. Even though they are generally a negative influence on fish the negative effects are related to features other than their stability. Channels with **Low** stability are usually characterized by fine substrates in riffles that often change location, have unstable and severely eroding banks, and a high bedload that slowly creeps downstream. Channels with **Moderate** stability are those that appear to maintain stable riffle/pool and channel characteristics, but which exhibit some symptoms of instability, *e.g.* high bedload, eroding or false banks, or show the effects of wide fluctuations in water level. Channels with **High** stability have stable banks and substrates, and little or no erosion and bedload.

e) *Modifications/Other* - Check the appropriate box if impounded, islands present, or leveed (these are not included in the QHEI scoring) as well as the appropriate source of habitat modifications.

The maximum QHEI metric score for Channel Morphology is **20 points**.

Metric 4: Riparian Zone and Bank Erosion

This metric emphasizes the quality of the riparian buffer zone and quality of the floodplain vegetation. This includes riparian zone width, floodplain quality, and extent of bank erosion. Each of the three components require scoring the left *and* right banks (looking downstream). The *average* of the left and right banks is taken to derive the component value. One box per bank should be checked unless conditions are considered to be intermediate between two categories; in these cases *check two boxes and* ***average*** *their scores.*

a) *Width of the Floodplain* - This is the width of the riparian (stream side) vegetation. Width estimates are only done for forest, shrub, swamp, and old field vegetation. Old field refers to the a fairly mature successional field that has stable, woody plant growth; this generally does not include weedy urban or industrial lots that often still have high runoff potential. Two boxes, one each for the left and right bank (looking downstream), should be checked and then averaged.

b) *Floodplain Quality* - The two most predominant floodplain quality types should be checked, one each for the left and right banks (includes urban, residential, etc.), and then averaged. By floodplain we mean the areas *immediately outside* of the riparian zone *or greater than 100 feet from the stream*, whichever is wider on each side of the stream. These are areas adjacent to the stream that can have direct runoff and erosional effects during normal wet weather. We do not limit it to the riparian zone and it is much less encompassing than the stream basin.

c) *Bank Erosion* - The following Streambank Soil Alteration Ratings from Platts *et al.* (1983) should be used; check one box for each side of the stream and average the scores. False banks are used in the sense of Platts *et al.* (1983) to mean banks that are no longer adjacent to the normal flow of the channel but have been moved back into the floodplain most commonly as a result of livestock trampling.

1) **None** - streambanks are stable and not being altered by water flows or animals (e.g. livestock) - Score **3**.
2) **Little** - streambanks are stable, but are being lightly altered along the transect line; less than 25% of the streambank is receiving any kind of stress, and if stress is being received it is very light; less than 25% of the streambank is false, broken down or eroding - Score **3**.
3) **Moderate** - streambanks are receiving moderate alteration along the transect line; at least 50 percent of the streambank is in a natural stable condition; less than 50% of the streambank is false, broken down or eroding; false banks are rated as altered - Score **2**.
4) **Heavy** - streambanks have received major alterations along the transect line; less than 50% of the streambank is in a stable condition; over 50% of the streambank is false, broken down, or eroding - Score **1**.
5) **Severe** - streambanks along the transect line are severely altered; less than 25% of the streambank is in a stable condition; over 75% of the streambank is false, broken down, or eroding - Score **1**.

The maximum score for Riparian Zone and Erosion metric is **10 points**.

Metric 5: Pool/Glide and Riffle-Run Quality

This metric emphasizes the quality of the pool, glide and/or riffle-run habitats. This includes pool depth, overall diversity of current velocities (in pools *and* riffles), pool morphology, riffle-run depth, riffle-run substrate, and riffle-run substrate quality.

A) **Pool/Glide Quality**

1) *Maximum depth of pool or glide*; check one box only (Score **0** to **6**). Pools or glides with maximum depths of *less than* 20 cm are considered to have lost their function and the *total metric* is scored a **0**. No other characteristics need be scored in this case.

2) *Current Types* - check each current type that is present in the stream (including riffles and runs; score - 2 to 4), definitions are:

Torrential - extremely turbulent and fast flow with large standing waves; water surface is very broken with no definable, connected surface; usually limited to gorges and dam spillway tailwaters.

Fast - mostly non-turbulent flow with small standing waves in riffle-run areas; water surface may be partially broken, but there is a visibly connected surface.

Moderate - non-turbulent flow that is detectable and visible (i.e. floating objects are readily transported downstream); water surface is visibly connected.

Slow - water flow is perceptible, but very sluggish.

Eddies - small areas of circular current motion usually formed in pools immediately downstream from riffle-run areas.

Interstitial - water flow that is perceptible only in the interstitial spaces between substrate particles in riffle-run areas.

Intermittent - no flow is evident anywhere leaving standing pools that are separated by dry areas.

4) *Morphology* - Check *Wide* if pools are wider than riffles, *Equal* if pools and riffles are the same width, and *Narrow* if the riffles are wider than the pools (Score **0** to **2**). If the morphology varies throughout the site *average* the types. If the entire stream area (including areas outside of the sampling zone) is pool or riffle, then check riffle = pool.

Although the theoretical maximum score is > 12 the maximum score assigned for the QHEI for the Pool Quality metric is limited to **12 points.**

B) **Riffle-Run Quality**

(score **0** for this metric if no riffles are present)

1) *Riffle/Run Depth* - select one box that most closely describes the depth characteristics of the riffle (Score **0 to 4**). If the riffle is generally less than 5 cm in depth riffles are considered to have loss their function and the entire riffle metric is scored a **0**.

2) *Riffle/Run Substrate Stability*—select one box from each that best describes the substrate type and stability of the riffle habitats (Score **0** to **2**).

3) *Riffle/Run Embeddedness*—**Embeddedness** is the degree that cobble, gravel, and boulder substrates are surrounded or covered by fine material (sand, silt). We consider substrates embedded if >50% of surface of the substrates are embedded in fine material—these substrates cannot be easily dislodged. This also includes substrates that are concreted. Boxes are checked for *extensiveness* (riffle area of sampling

zone) with embedded substrates: **Extensive** — > 75% of stream area, **Moderate** — 50-75%, **Sparse** — 25-50%, **Low** — < 25%.

The maximum score assigned for the QHEI for the Riffle/Run Quality metric is **8 points.**

Metric 6: Map Gradient

Local or map gradient is calculated from USGS 7.5 minute topographic maps by measuring the elevation drop through the sampling area.This is done by measuring the stream length between the first contour line upstream and the first contour line downstream of the sampling site and dividing the distance by the contour interval. If the contour lines are closely "packed" a minimum distance of at least one mile should be used. Some judgement may need to be exercised in certain anomalous areas (*e.g.* in the vicinity of waterfalls, impounded areas, etc.) and this can be compared to an in-field, visual estimate which is recorded on the back of the habitat sheet.

Scoring for ranges of stream gradient takes into account the varying influence of gradient with stream size, preferably measured as drainage area in square miles or stream width. Gradient classifications (Table V-4-3) were modified from Trautman (p 139, 1981) and scores were assigned, by stream size category, after examining scatterplots of IBI vs natural log of gradient in feet/mile. Scores are listed in Table V-4-3

The maximum QHEI metric score for Gradient is **10 points**.

*Computing the Total **QHEI** Score:*

To compute the total **QHEI** score, add the components of each metric to obtain the metric scores and then sum the metric scores to obtain the total **QHEI** score. The **QHEI** metric scores cannot exceed the Metric Maximum Score indicated below.

QHEI SCORING (Maximum = 100)

QHEI Metric	Metric Component	Component Scoring Range	Metric Max. Score
1) Substrate	a) Type	0 to 21	20
	b) Quality	-5 to 3	
2) Instream Cover	a) Type	0 to 10	20
	b) Amount	1 to 11	
3) Channel Morphology	a) Sinuosity	1 to 4	20
	b) Development	1 to 7	
	c) Channelization	1 to 6	
	d) Stability	1 to 3	
4) Riparian Zone	a) Width	0 to 4	10
	b) Quality	0 to 3	
	c) Bank Erosion	1 to 3	
5a) Pool Quality	a) Max. Depth	0 to 6	12
	b) Current	-2 to 4	
	c) Morphology	0 to 2	
5b) Riffle Quality	a) Depth	0 to 4	8
	b) Substr Stab.	0 to 2	
	c) Substr Embd.	-1 to 2	
6)Gradient		2 to 15	10
TOTAL	Maximum Score		100

Additional Information

Additional information is recorded on the reverse side of the Site Description Sheet (Fig. V-4-6) and is described as follows:

1) *Additional Comments/Pollution Impacts* - Different types of pollution sources (*e.g.* wastewater treatment plant, feedlot, industrial discharge, nonpoint source

Table V-4-3. Classification of stream gradients for Ohio, corrected for stream size. Modified from Trautman (p 139, 1981). Scores were derived from plots of IBI versus the natural log of gradient for each stream size category.

Average Stream Width (m)	Drainage Area (sq mi)	Gradient (ft/mile) Very Low	Low	Low-Moderate	Moderate	Moderate High	High	Very High[1]
0.3-4.7	0-9.2	0-1.0 2	1.1-5.0 4	5.1-10.0 6	10.1-15.0 8	15.1-20 10	20.1-30 10	30.1-40 8
4.8-9.2	9.2-41.6	0-1.0 2	1.1-3.0 4	3.1-6.0 6	6.1-12.0 10	12.1-18.0 10	18.0-30 8	30.1-40 6
9.2-13.8	41.6-103.7	0-1.0 2	1.1-.2.5 4	2.6-5.0 6	5.1-7.5 8	7.6-12.0 10	12.1-20 8	20.1-30 6
13.9-30.6	103.7-622.9	0-1.0 4	1.1-2.0 6	2.1-4.0 8	4.1-6.0 10	6.1-10.0 10	10.1-15 8	15.1-25 6
>30.6	>622.9	-	0-0.5 6	0.6-1.0 8	1.1-2.5 10	2.6-4.0 10	4.1-9.0 10	>9.0 8

[1] Any site with a gradient > than the upper bound of the "very high" gradient classification is assigned a score of 4.

APPENDIX C

STL LABORATORY QA/QC PLAN

A copy of the STL Laboratory QA/QC Plan can be obtained from JFNew, STL Laboratories, or the Indiana Department of Environmental Management.

APPENDIX D

QHEI DATA SHEET AND MACROINVERTEBRATE IDENTIFICATION DATA SHEET

STREAM: ______________ **RIVER MILE:** ________ **DATE:** ________ **QHEI SCORE** [ ]

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) **SUBSTRATE SCORE** [ ]

TYPE	POOL	RIFFLE	TYPE	POOL	RIFFLE
BLDER/SLAB(10)	___	___	GRAVEL(7)	___	___
BOULDER(9)	___	___	SAND(6)	___	___
COBBLE(8)	___	___	BEDROCK(5)	___	___
HARDPAN(4)	___	___	DETRITUS(3)	___	___
MUCK/SILT(2)	___	___	ARTIFIC(0)	___	___

SUBSTRATE ORIGIN (all): LIMESTONE(1), TILLS(1), SANDSTONE(0), SHALE(-1), COAL FINES(-2), RIP/RAP(0), HARDPAN(0)

SILT COVER (one): SILT-HEAVY(-2), SILT-NORM(0), SILT-MOD(-1), SILT-FREE(1)

Extent of Embeddedness (check one): EXTENSIVE(-2), LOW(0), MODERATE(-1), NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [ ] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: ______________

2) INSTREAM COVER: **COVER SCORE** [ ]

TYPE (Check all that apply)

- UNDERCUT BANKS(1)
- OVERHANGING VEGETATION(1)
- SHALLOWS (IN SLOW WATER)(1)
- DEEP POOLS(2)
- ROOTWADS(1)
- BOULDERS(1)
- OXBOWS(1)
- AQUATIC MACROPHYTES(1)
- LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- EXTENSIVE >75%(11)
- MODERATE 25-75%(7)
- SPARSE 5-25%(3)
- NEARLY ABSENT <5%(1)

COMMENTS: ______________

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) **CHANNEL SCORE** [ ]

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATION/OTHER	
HIGH(4)	EXCELLENT(7)	NONE(6)	HIGH(3)	SNAGGING	IMPOUND
MODERATE(3)	GOOD(5)	RECOVERED(4)	MODERATE(2)	RELOCATION	ISLAND
LOW(2)	FAIR(3)	RECOVERING(3)	LOW(1)	CANOPY REMOVAL	LEVEED
NONE(1)	POOR(1)	RECENT OR NO RECOVERY(1)		DREDGING	BANK SHAPING
				ONE SIDE CHANNEL MODIFICATION	

COMMENTS: ______________

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) **RIPARIAN SCORE** [ ]

River Right Looking Downstream

RIPARIAN WIDTH (per bank) — L R (per bank)

- WIDE >150 ft.(4)
- MODERATE 30-150 ft.(3)
- NARROW 15-30 ft.(2)
- VERY NARROW 3-15 ft.(1)
- NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY — L R (most predominant per bank)

- FOREST, SWAMP(3)
- OPEN PASTURE/ROW CROP(0)
- RESID.,PARK,NEW FIELD(1)
- FENCED PASTURE(1)

L R (per bank)

- URBAN OR INDUSTRIAL(0)
- SHRUB OR OLD FIELD(2)
- CONSERV. TILLAGE(1)
- MINING/CONSTRUCTION(0)

BANK EROSION — L R (per bank)

- NONE OR LITTLE(3)
- MODERATE(2)
- HEAVY OR SEVERE(1)

COMMENTS: ______________

5) POOL/GLIDE AND RIFFLE/RUN QUALITY **NO POOL = 0** **POOL SCORE** [ ]

MAX.DEPTH (Check 1)

- >4 ft.(6)
- 2.4-4 ft.(4)
- 1.2-2.4 ft.(2)
- <1.2 ft.(1)
- <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

- POOL WIDTH>RIFFLE WIDTH(2)
- POOL WIDTH=RIFFLE WIDTH(1)
- POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

- TORRENTIAL(-1)
- FAST(1)
- MODERATE(1)
- SLOW(1)
- EDDIES(1)
- INTERSTITIAL(-1)
- INTERMITTENT(-2)

COMMENTS: ______________

RIFFLE SCORE [ ]

RIFFLE/RUN DEPTH

- GENERALLY >4 in. MAX.>20 in.(4)
- GENERALLY >4 in. MAX.<20 in.(3)
- GENERALLY 2-4 in.(1)
- GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

- STABLE (e.g., Cobble,Boulder)(2)
- MOD.STABLE (e.g., Pea Gravel)(1)
- UNSTABLE (Gravel, Sand)(0)
- NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

- EXTENSIVE(-1)
- MODERATE(0)
- LOW(1)
- NONE(2)
- NO RIFFLE(0)

COMMENTS: ______________

6) GRADIENT (FEET/MILE): ______ **% POOL** ______ **% RIFFLE** ______ **% RUN** ______ **GRADIENT SCORE** [ ]

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OWM - BIOLOGICAL STUDIES
BENTHIC MACROINVERTEBRATE BENCH SHEET
PHASE 1 TAXONOMY

SAMPLE NUMBER:__________ ____ SITE: COUNTY: CREW CHIEF:
LOCATION: HYDROLOGIC UNIT: DATE OF COLLECTION:
ECOREGION: IASNRI: SORTER: LABEL CHECK:____

EPHEMEROPTERA

SIPHLONURIDAE (7) ____ METRETOPODIDAE (2) ____ BAETIDAE (4) ____ BAETISCIDAE (3) ____ HEPTAGENIIDAE (4) ____
EPHEMERELLIDAE (1) ____ TRICORYTHIDAE (4) ____ CAENIDAE (7) ____ OLIGONEURIIDAE (2) ____ LEPTOPHLEBIIDAE (2)____
POTAMANTHIDAE (4) ____ EPHEMERIDAE (4) ____ POLYMITARCYIDAE (2) ____

ODONATA **ZYGOPTERA**

CORDULEGASTRIDAE (3) ____ GOMPHIDAE (1) ____ AESHNIDAE (3) ____ MACROMIIDAE (3) ____ CORDULIIDAE (3) ____
LIBELLULIDAE (9) ____ CALOPTERYGIDAE (5) ____ LESTIDAE (9) ____ COENAGRIONIDAE (9) ____

PLECOPTERA

PTERONARCYIDAE (0) ____ TAENIOPTERYGIDAE (2) ____ NEMOURIDAE (2) ____ LEUCTRIDAE (0) ____ CAPNIIDAE (1) ____
PERLIDAE (1) ____ PERLODIDAE (2) ____ CHLOROPERLIDAE (1) ____

HEMIPTERA

MACROVELIIDAE ( ) ____ VELIIDAE ( ) ____ GERRIDAE ( ) ____ BELOSTOMATIDAE ( ) ____ NEPIDAE ( ) ____ CORIXIDAE ( ) ____
NOTONECTIDAE ( ) ____ PLEIDAE ( ) ____ SALDIDAE ( ) ____ HEBRIDAE ( ) ____ NAUCORIDAE ( ) ____ MESOVELIIDAE ( ) ____

MEGALOPTERA SIALIDAE (4) ____ CORYDALIDAE (1) ____ SISYRIDAE ( ) ____

TRICHOPTERA

PHILOPOTAMIDAE (3) ____ PSYCHOMYIIDAE (2) ____ POLYCENTROPODIDAE (6) ____ HYDROPSYCHIDAE (4) ____
RHYACOPHILIDAE (0) ____ GLOSSOSOMATIDAE (0) ____ HYDROPTILIDAE (4) ____ PHRYGANEIDAE (4) ____
BRACHYCENTRIDAE (1) ____ LEPIDOSTOMATIDAE (1) ____ HELICOPSYCHIDAE (3) ____ SERICOSTOMATIDAE (3) ____
ODONTOCERIDAE (0) ____ MOLANNIDAE (6) ____ LIMNEPHILIDAE (4) ____ LEPTOCERIDAE (4) ____

LEPIDOPTERA PYRALIDAE (5) ____ NOCTUIDAE ( ) ____

COLEOPTERA

GYRINIDAE( )____ HALIPLIDAE( )____ DYTISCIDAE( )____ HYDROPHILIDAE( )____ PSEPHENIDAE (4)____ DRYOPIDAE(5)____ ELMIDAE(4)____
SCIRTIDAE ( ) ____ STAPHYLINIDAE ( ) ____ CHRYSOMELIDAE ( ) ____ CURCULIONIDAE ( ) ____ HYDRAENIDAE ( ) ____

DIPTERA

BLEPHARICERIDAE (0) ____ TIPULIDAE (3) ____ PSYCHODIDAE (10) ____ TABANIDAE (6) ____ ATHERICIDAE (2) ____
CHIRONOMIDAE(blood red)(8) ____ CHIRONOMIDAE(all other)(6) ____ SYRPHIDAE (10) ____ EPHYDRIDAE (6) ____ MUSCIDAE (6) ____
DOLICHOPODIDAE (4) ____ EMPIDIDAE (6) ____ CERATOPOGONIDAE (6) ____ SIMULIIDAE (6) ____ CHAOBORIDAE ( ) ____

COLLEMBOLA ISOTOMIDAE ( ) ____ PODURIDAE ( ) ____ SMINTHURIDAE ( ) ____ ENTOMOBRYIDAE ( ) ____

OTHER ARTHROPODA

ACARI (4) ____ ASELLIDAE (8) ____ GAMMARIDAE (4) ____ TALITRIDAE (8) ____ ASTACIDAE (6) ____

MOLLUSCA

GASTROPODA FERRISSIA (6) ____ HELISOMA (6) ____ LYMNAEA (6) ____ AMNICOLA (8) ____ PLEUROCERIDAE ( ) ____ VIVIPARIDAE () ____
BITHYNIA (8) ____ GYRAULUS (8) ____ PHYSA (8) ____ PLANORBIDAE ( ) ____ HYDROBIIDAE ( ) ____ ANCYLIDAE ( ) ____

PELECYPODA SPHAERIIDAE (8) ____ CORBICULA ( ) ____ DRIESSENIA ( ) ____

PLATYHELMINTHES TURBELLARIA (4) ____ ANNELIDA ( ) ____ OLIGOCHAETA ( ) ____ TUBIFICIDAE ( ) ____ NAIDIDAE ( ) ____
HIRUDINEA ( ) ____ HELOBDELLA (10) ____ BRANCHIOBDELLIDA ( ) ____ ERPOBDELLIDAE ( ) ____ NEMATODA ( ) ____

NUMBER OF VIALS FORWARDED:____ PRELIMINARY NUMBER OF TAXA:____ NUMBER OF INDIVIDUALS:____

HBI:____ EPT COUNT:____ EPT ABUN./CHIR. ABUN.:____ CHIRONOMID COUNT:____

% DOMINANT TAXON:____ EPT INDEX:____ EPT/TOTAL COUNT:____

PHASE 1 IDENTIFICATION COMPLETED BY:____ DATE COMPLETED:____ COUNTS & CALCULATION CHECK:____ ____

APPENDIX H:

Subwatershed Modeling

COFFEE CREEK SUBWATERSHED MODELING

Introduction

The primary purpose of the modeling exercise conducted as part of the Coffee Creek Watershed Management Plan development was to provide additional information, primarily a comparison of pollutant loading rates among the four major subwatersheds, to supplement the goal setting and decision making processes during the management plan's development. A variety of models were examined to determine their ability to achieve this objective. The United States Environmental Protection Agency (1997) recommends the use of simple models when the data objectives are to "support an assessment of the relative significance of different sources, guide decisions for management plans, and focus continuing monitoring efforts." Based on this recommendation and budgetary and data availability constraints, the United States Environmental Protection Agency's (USEPA) Spreadsheet Tool for the Estimation of Pollutant Load (STEPL) model version 2.0 was utilized to assess potential pollutant loading from each of the four major subwatersheds in the Coffee Creek watershed.

STEPL is a simple watershed-scale loading model. Despite being a simple model, it incorporates local data (local weather, county Universal Soil Loss Equation values, septic system data, watershed specific land use coverages) in its calculation of pollutant loading rates. The model uses this data and empirically derived runoff curve numbers and runoff nutrient concentrations to estimate loading rates for four pollutants: nitrogen, phosphorus, sediment, and biological oxygen demand (BOD). Results of the model using subwatershed data from Johnson Ditch, Pope O'Connor Ditch, Shooter Ditch, and the Suman Road Tributary subwatersheds is detailed below.

Model Input

Tables 1–8 show the values entered into the model for various parameters. Because the model employs local (typically county) data for many defaults and because the model was used primarily for screening purposes rather than to quantify exact pollutant loads from the watershed, many of these defaults were accepted. The accepted defaults include: weather station data (average rainfall, number of rain event days, and rain correction factors), Universal Soil Loss Equation (USLE) parameter values, average soil hydrologic group values, runoff curve numbers for each land use, and nutrient concentrations in runoff.

Table 1. Watershed land use utilized in the STEPL model.

Watershed	Urban (acres)	Cropland (acres)	Pastureland (acres)	Forest (acres)	Total (acres)
Johnson Ditch	19.05	71.01	135.65	509.53	735.24
Pope O'Connor Ditch	353.79	232.78	256.29	568.42	1411.28
Shooter Ditch	23.12	165.01	184.76	94.85	467.74
Suman Road Tributary	90.92	102.9	277.65	997.61	1469.08

Table 2. Precipitation values and correction factors utilized in the STEPL model. These are the defaults for Porter County, Indiana.

Factor	Value
Rain Correction Factor*	0.9
Rain Days Correction Factor**	0.6
Annual Rainfall	35.01 inches
Rain Days	110.2 days
Average Rainfall/Event	0.477 inches

*The percent of rainfall events that exceed 5 mm per event. **The percent of rain events that generate runoff.

Table 3. Septic system data input into the STEPL model.

Watershed	Number of Septic Systems	Population per Septic System	Septic Failure Rate*
Johnson Ditch	62	2.62	1%
Pope O'Connor Ditch	287	2.62	1%
Shooter Ditch	40	2.62	1%
Suman Road Tributary	91	2.62	1%

*Source: Keith Letta, Porter County Health Department.

Table 4. Modified Universal Soil Loss Equation (USLE) parameters utilized in STEPL model. These are the defaults for Porter County, Indiana.

CROPLAND					
	R	**K**	**LS**	**C**	**P**
Johnson Ditch	160	0.287	0.264	0.2	1.000
Pope O'Connor Ditch	160	0.287	0.264	0.2	1.000
Shooter Ditch	160	0.287	0.264	0.2	1.000
Suman Road Tributary	160	0.287	0.264	0.2	1.000
PASTURELAND					
	R	**K**	**LS**	**C**	**P**
Johnson Ditch	160	0.287	0.264	0.04	1.000
Pope O'Connor Ditch	160	0.287	0.264	0.04	1.000
Shooter Ditch	160	0.287	0.264	0.04	1.000
Suman Road Tributary	160	0.287	0.264	0.04	1.000
FOREST					
	R	**K**	**LS**	**C**	**P**
Johnson Ditch	160	0.287	0.264	0.003	1.000
Pope O'Connor Ditch	160	0.287	0.264	0.003	1.000
Shooter Ditch	160	0.287	0.264	0.003	1.000
Suman Road Tributary	160	0.287	0.264	0.003	1.000

Table 5. Soil nutrient concentrations and hydrologic groups utilized in the STEPL model. These are the defaults for Soil Hydrologic Group (SHG) in Porter County, Indiana.

Watershed	Soil Hydrologic Group	Soil N Concentration	Soil P Concentration	Soil BOD Concentration
Johnson Ditch	SHG B	0.08%	0.03%	0.16%
Pope O'Connor Ditch	SHG B	0.08%	0.03%	0.16%
Shooter Ditch	SHG B	0.08%	0.03%	0.16%
Suman Road Tributary	SHG B	0.08%	0.03%	0.16%

Table 6. Reference runoff curve numbers utilized for STEPL model. These are the defaults for the STEPL model.

Soil Hydrologic Group	A	B	C	D
Urban	83	89	92	93
Cropland	67	78	85	89
Pastureland	49	69	79	84
Forest	39	60	73	79

Table 7. Runoff nutrient concentrations utilized in STEPL model. These are the defaults for the STEPL model.

	Nitrogen	Phosphorus	BOD
Pastureland	4 mg/L	0.3 mg/L	13 mg/L
Forest	0.2 mg/L	0.1 mg/L	0.5 mg/L

Table 8. Urban land use distribution utilized in the STEPL model.

	Johnson Ditch	Pope O'Connor Ditch	Shooter Ditch	Suman Road Tributary
Urban Sewered	0%	85%	0%	0%
Commercial	7%	15%	31%	17%
Industrial	0%	0%	0%	0%
Institutional	0%	0%	0%	0%
Transportation	0%	0%	0%	0%
Multi-Family	0%	14%	0%	1%
Single-Family	60%	47%	69%	64%
Agriculture	0%	0%	0%	0%
Vacant (developed)	0%	0%	0%	0%
Open Space	33%	24%	0%	18%
Total Area	**100%**	**100%**	**100%**	**100%**

Land use data for the STEPL model was taken from the USGS EROS data set. This data set was modified slightly based on a field reconnaissance of the Coffee Creek watershed. Because

STEPL model uses only broad land use categories in estimating pollutant loads, more specific land use categories in the EROS data set for each subwatershed were grouped into the appropriate broad STEPL land use category. Both evergreen and deciduous forested land were placed in STEPL's "forest" catagory. For the purposes of this modeling exercise, wetland nutrient export was assumed to be more similar to forested land nutrient export than export from other land uses. Consequently, all wetland acreage was placed in the "forest" category. The EROS "row crops" and "small grains" were placed in the STEPL "cropland" category. The EROS "grassland/herbaceous" and "pasture/hay" were lumped into the STEPL "pasture" category. All other EROS land use types were placed in the STEPL "urban" category. Table 9 summarizes the data reduction described above.

Table 9. Conversion of EROS land use categories to STEPL land use categories.

EROS land use category	**STEPL land use category**
Deciduous forest	Forest
Emergent herbaceous wetlands	Forest
Evergreen forest	Forest
Grassland/herbaceous	Pasture
High intensity residential	Urban
High intensity commercial/industrial/transportation	Urban
Low intensity residential	Urban
Other grasses (urban/recreational parks)	Urban
Pasture/hay	Pasture
Row crops	Cropland
Small grains	Cropland
Woody wetlands	Forest

The option to modify urban land use distribution was utilized since detailed land use data was available with the EROS data set (Table 8). Because rural areas of the Coffee Creek watershed lack storm sewers, a zero was entered for "% urban sewered" for the Johnson Ditch, Shooter Ditch, and Suman Road Tributary subwatersheds. A large portion of the urban land in the Pope O'Connor Ditch subwatershed possesses storm sewers (Paul Williams, Chesterton Utilities, personal communication). For the purposes of the model, it was estimated that 85% of the urban land in the Pope O'Connor Ditch subwatershed possessed storm sewers. Based on the definitions of land use provided in the EROS data set documentation, land in the EROS "high intensity commercial/industrial/transportation" was considered "commercial" for the STEPL model. Similarly, EROS "high intensity residential", "low intensity residential", and "other grasses (urban/recreational parks)" categories were considered "multi-family", "single-family", and "open space", respectively, for the STEPL model.

Septic data for the STEPL model was derived from United States 2000 Census data and information from the Porter County Health Department and the Chesterton City Engineer's Office. The STEPL model requires user input for three septic data variables: number of septic systems, population per septic system, and septic failure rate percentage. The U.S. 2000 Census data indicates that an average of 2.62 people live in each household in Porter County. Keith Letta, Porter County Health Department supervisor (personal communication) provided an estimate of 1% for the septic failure rate percentage. To estimate the number of septic systems in the three rural subwatersheds (Suman Road Tributary, Johnson Ditch, and Shooter Ditch), an estimate of the total population of each subwatershed was first developed. U.S. 2000 Census data for Jackson Township in Porter County was divided by the total acreage of the township to obtain an estimate of the number of people per acre in the township. (Jackson Township data was used since much of these three rural subwatersheds lie in Jackson Township.) The number of people per acre was then multiplied by the acreage in each subwatershed to estimate the number of people in each subwatershed. This number was then divided by 2.62 to determine the number of households in each subwatershed. (The U.S. 2000 Census data indicates that an average of 2.62 people live in each household in Porter County.) It was assumed that each household would have only one septic system so the estimate for number of households was used as an estimate of the number of septic systems per subwatershed.

The procedure described above was modified slightly to estimate the number of septic systems in the Pope O'Connor Ditch subwatershed. U.S. 2000 Census data from census tract 0502.01, which encompasses roughly the eastern half of Westchester Township, was used to estimate the number of people living in the Pope O'Connor Ditch subwatershed. Paul Williams of Chesterton Utilities provided information on the extent of sanitary sewer coverage in Pope O'Connor Ditch subwatershed. This acreage was subtracted from the subwatershed's total acreage in determining the number of people on septic systems in the subwatershed. The number of people in the Pope O'Connor Ditch subwatershed on septic systems was divided by 2.62 to estimate the number of septic systems in the subwatershed.

Results And Discussion

Figures 1-8 display the results of the modeling exercise. Figures 1-4 show the pollutant loading rates for each of the four pollutants. Because subwatershed size varies, variation in pollutant loading rate is expected. Larger subwatersheds are expected to deliver more pollutants to their respective tributaries than smaller subwatersheds. To facilitate a comparison of pollutant loading rates among subwatersheds, the pollutant loading rates for each subwatershed were normalized by dividing the pollutant loading rate by subwatershed size. The result is an areal pollution loading rate, or pollutant loading rate per acre of subwatershed. Figures 5-8 show the areal pollutant loading rates for each pollutant. Figures 9-12 present the pollutant loads by land use for each of the four subwatersheds.

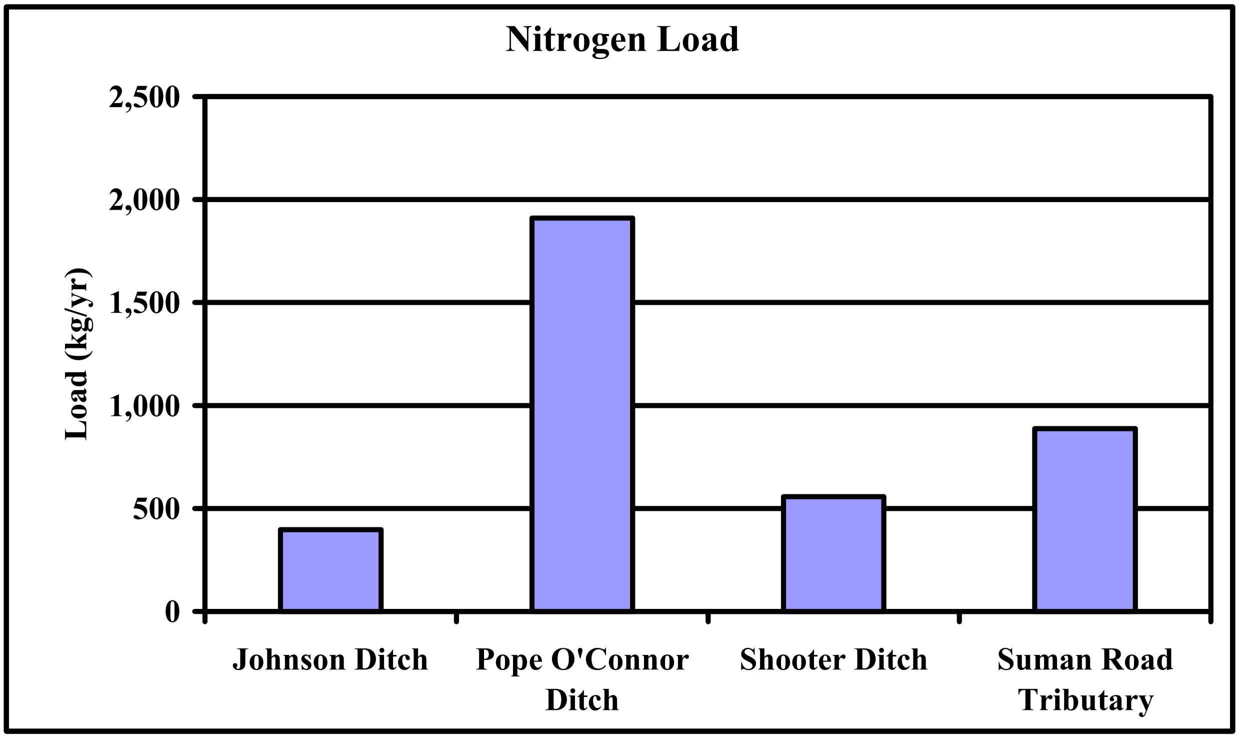

Figure 1. Nitrogen loading rate calculated for each subwatershed.

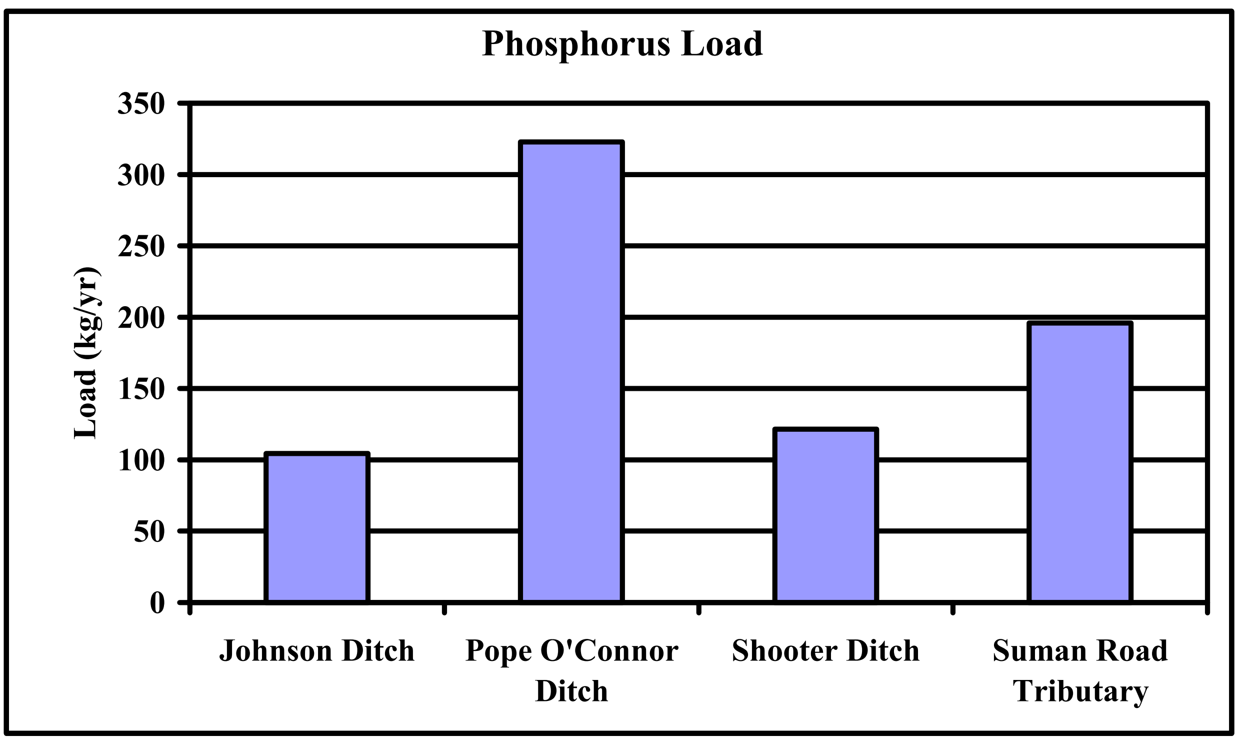

Figure 2. Phosphorus loading rate calculated for each subwatershed.

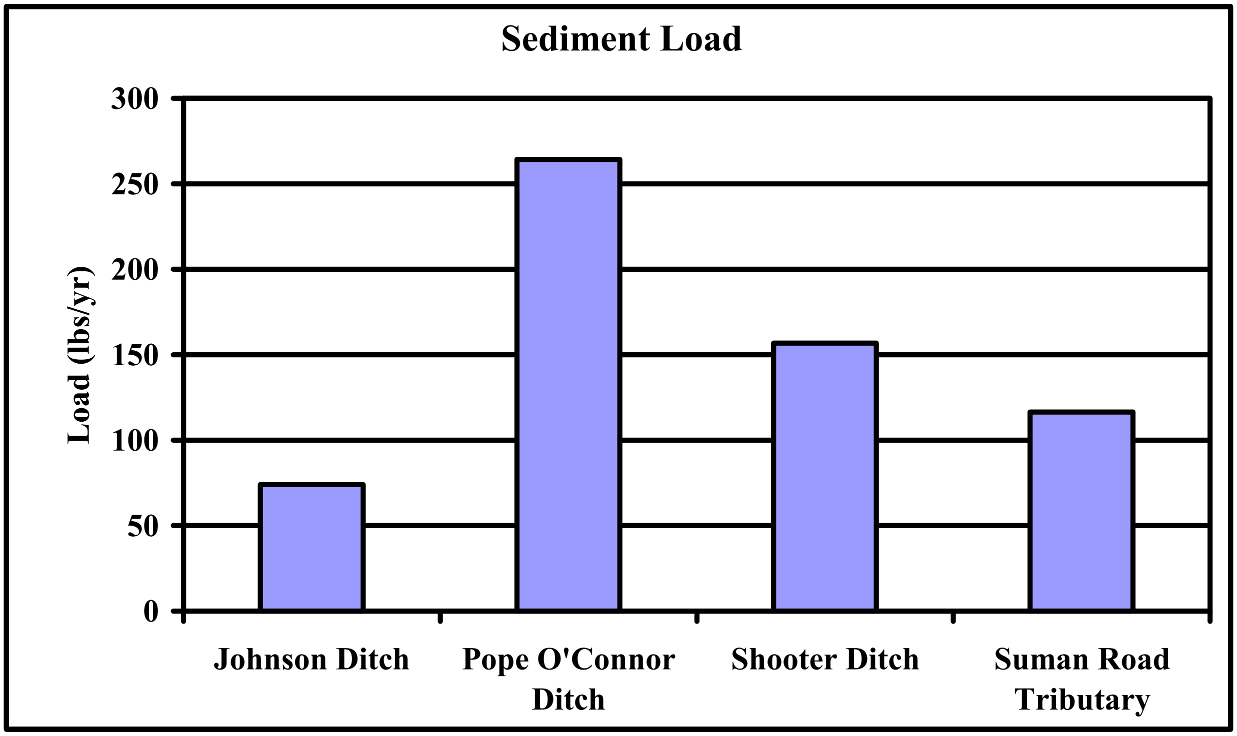

Figure 3. Sediment loading rate calculated for each subwatershed.

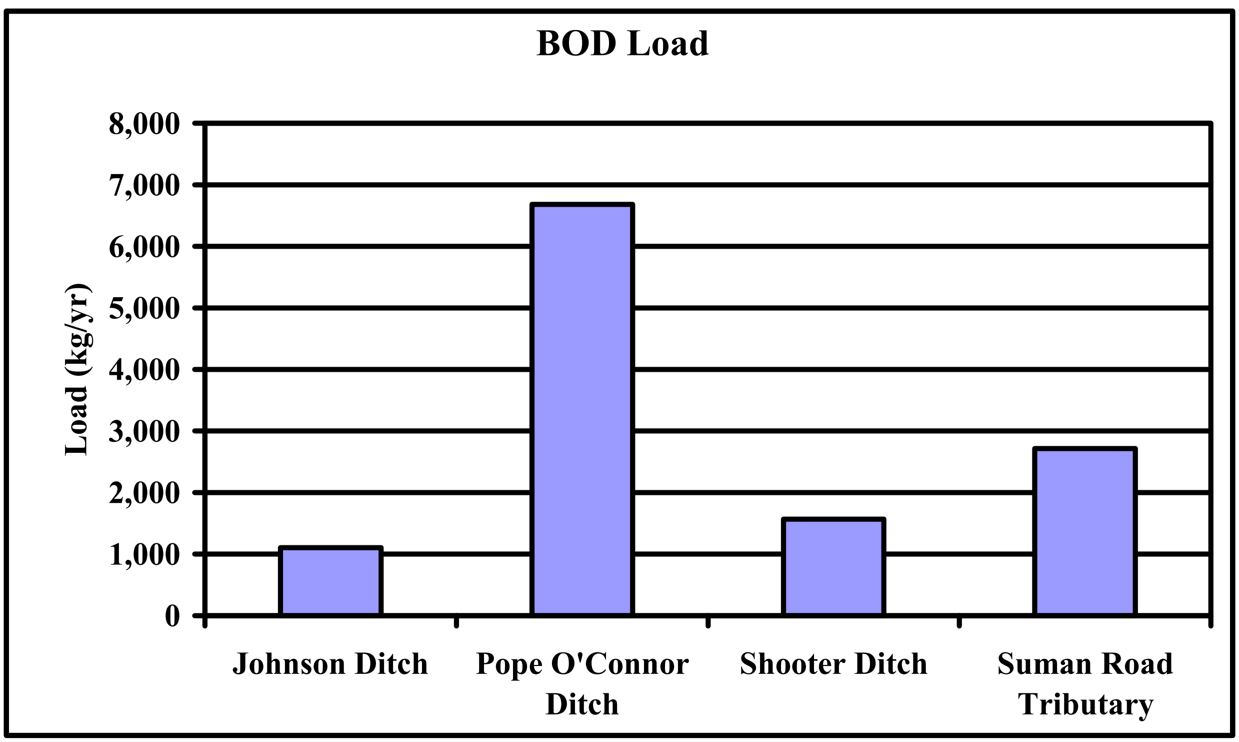

Figure 4. Biological oxygen demand (BOD) loading rate calculated for each subwatershed.

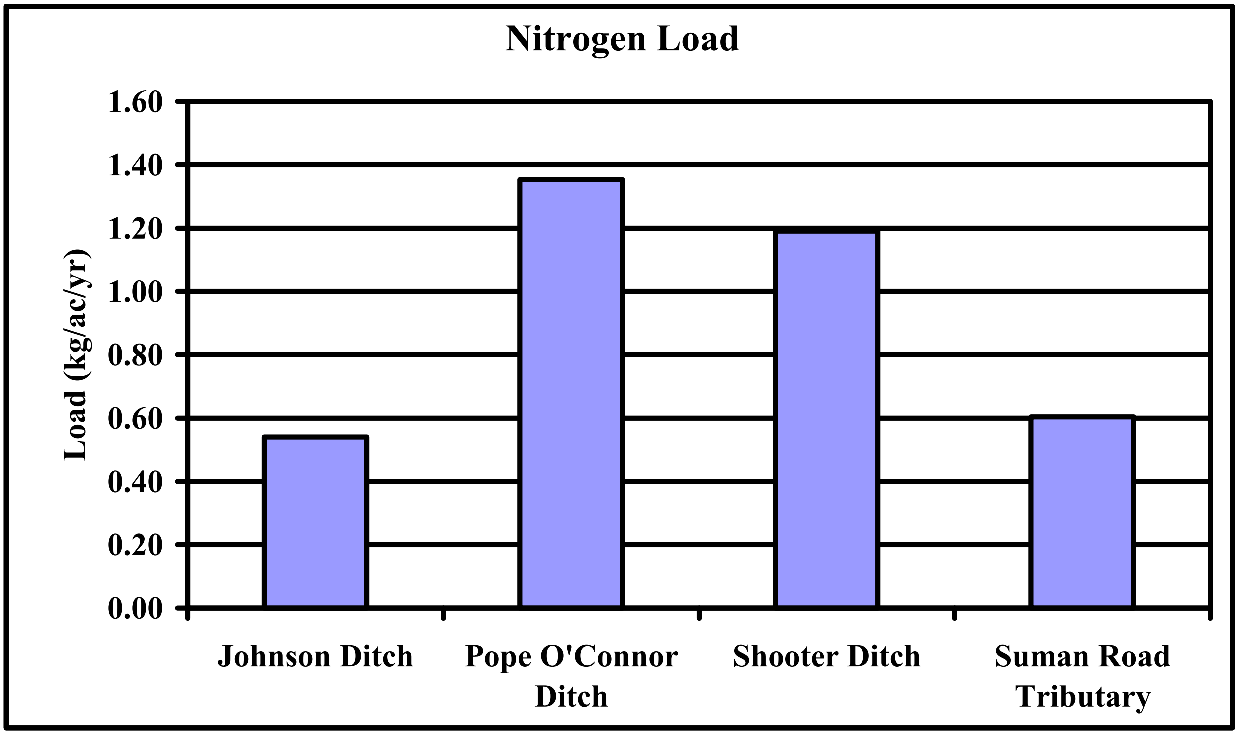

Figure 5. Areal nitrogen loading rate calculated for each subwatershed.

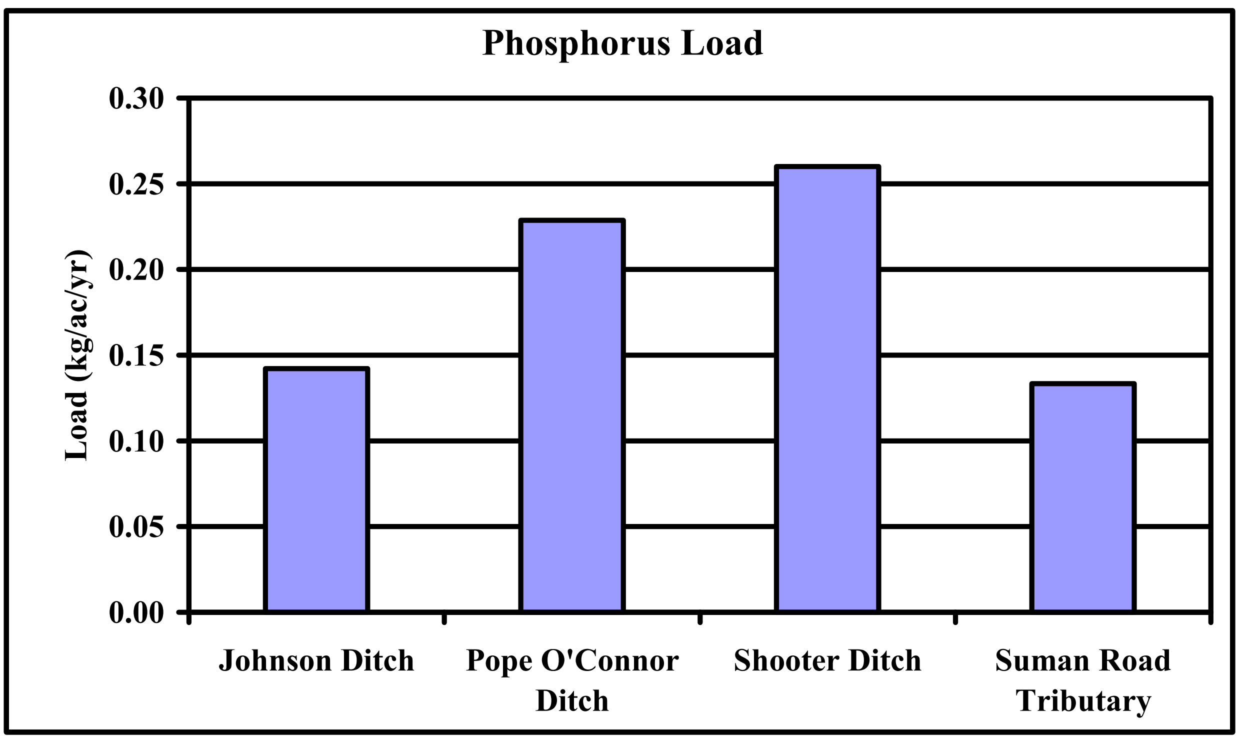

Figure 6. Areal phosphorus loading rate calculated for each subwatershed.

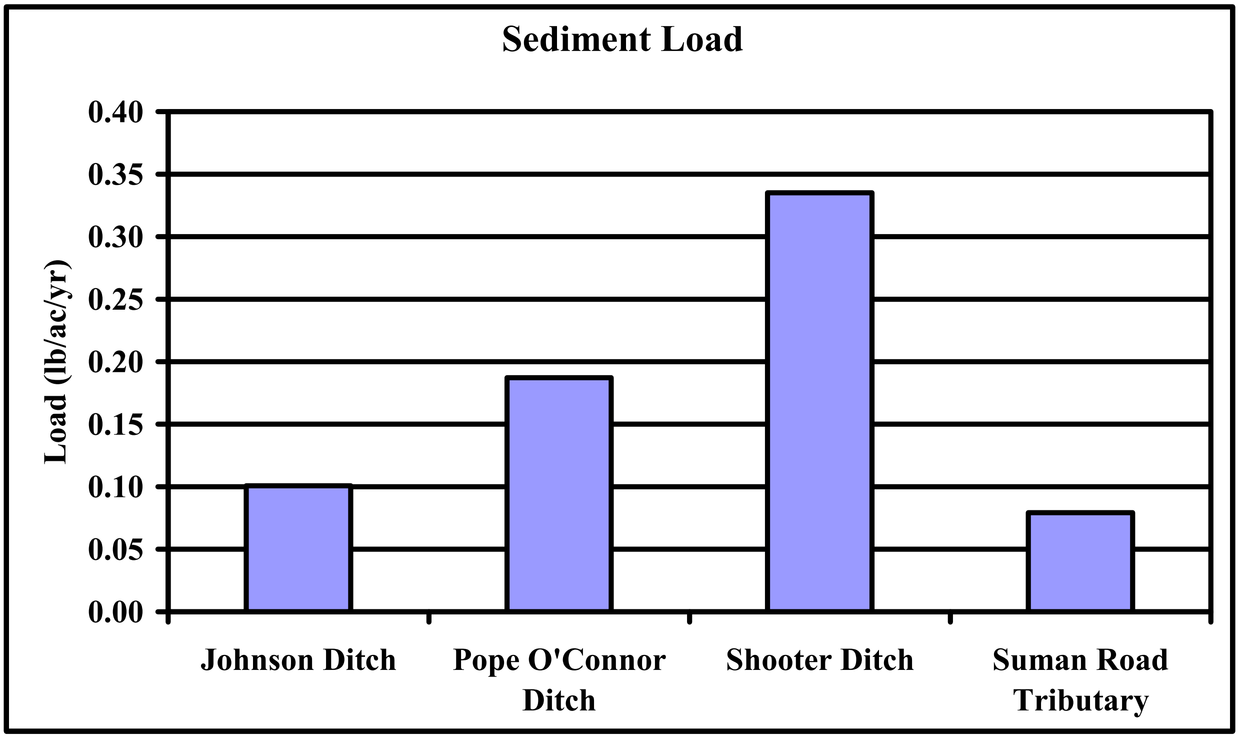

Figure 7. Areal sediment loading rate calculated for each subwatershed.

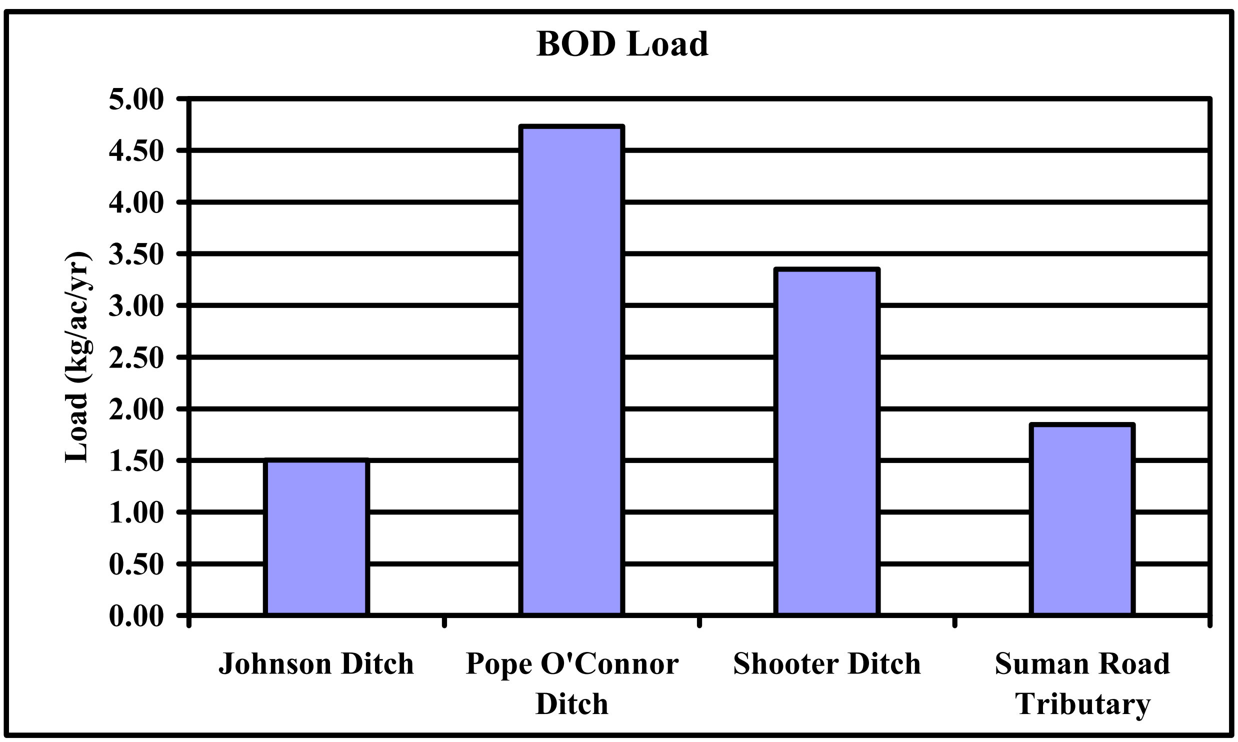

Figure 8. Areal BOD loading rate calculated for each subwatershed.

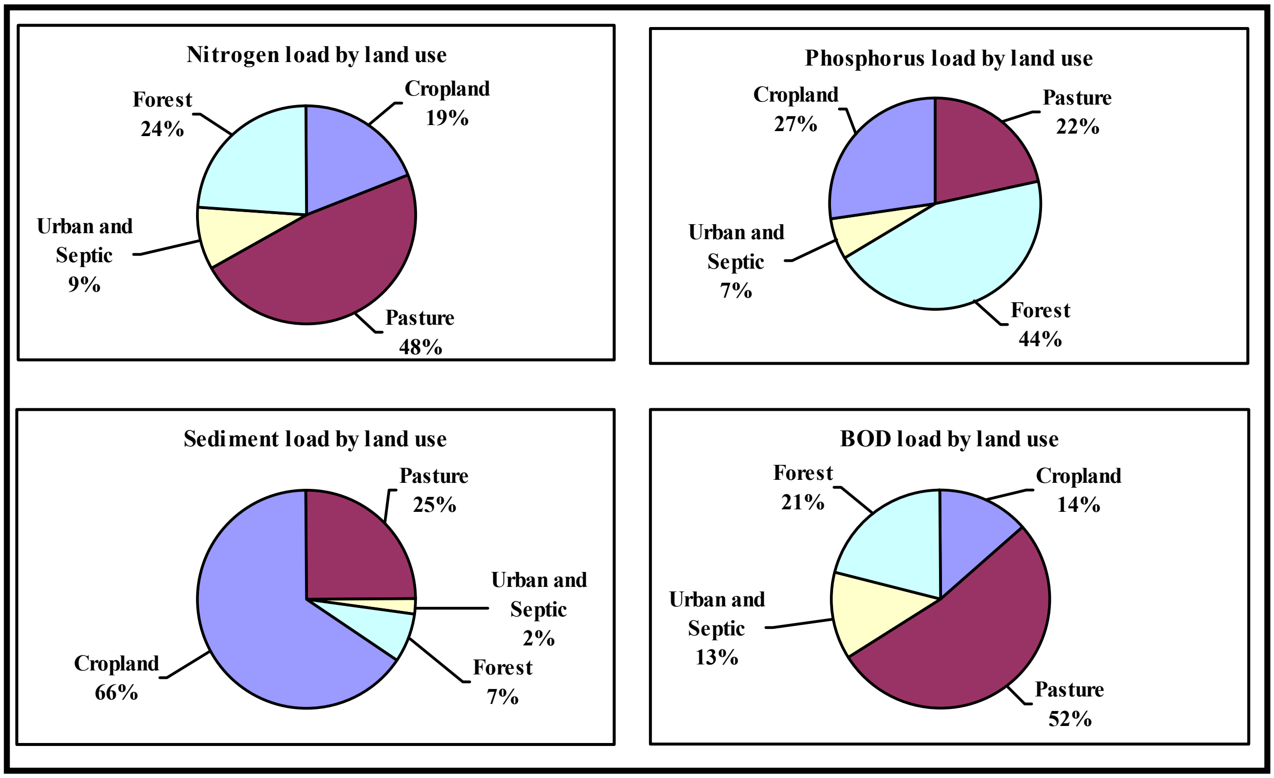

Figure 9. Sources of nitrogen, phosphorus, sediment, and BOD in the Johnson Ditch subwatershed.

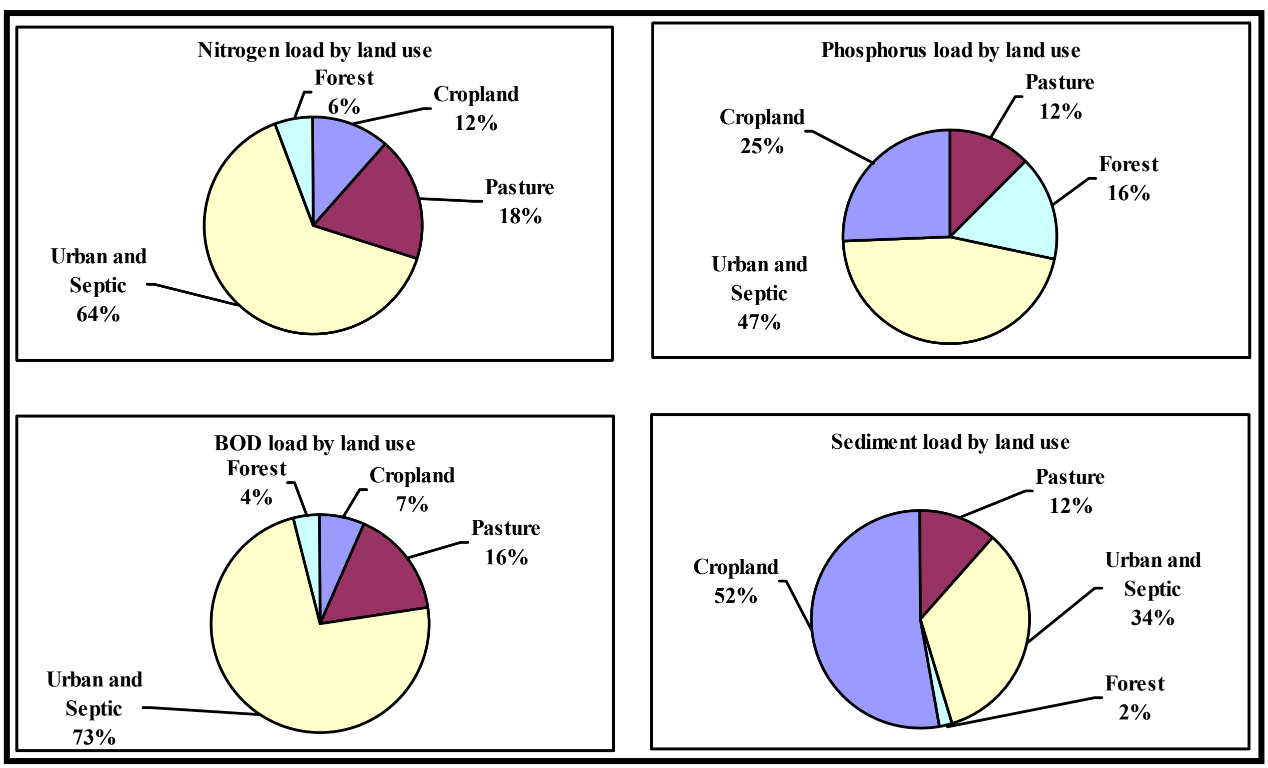

Figure 10. Sources of nitrogen, phosphorus, sediment, and BOD in the Pope O'Connor Ditch subwatershed.

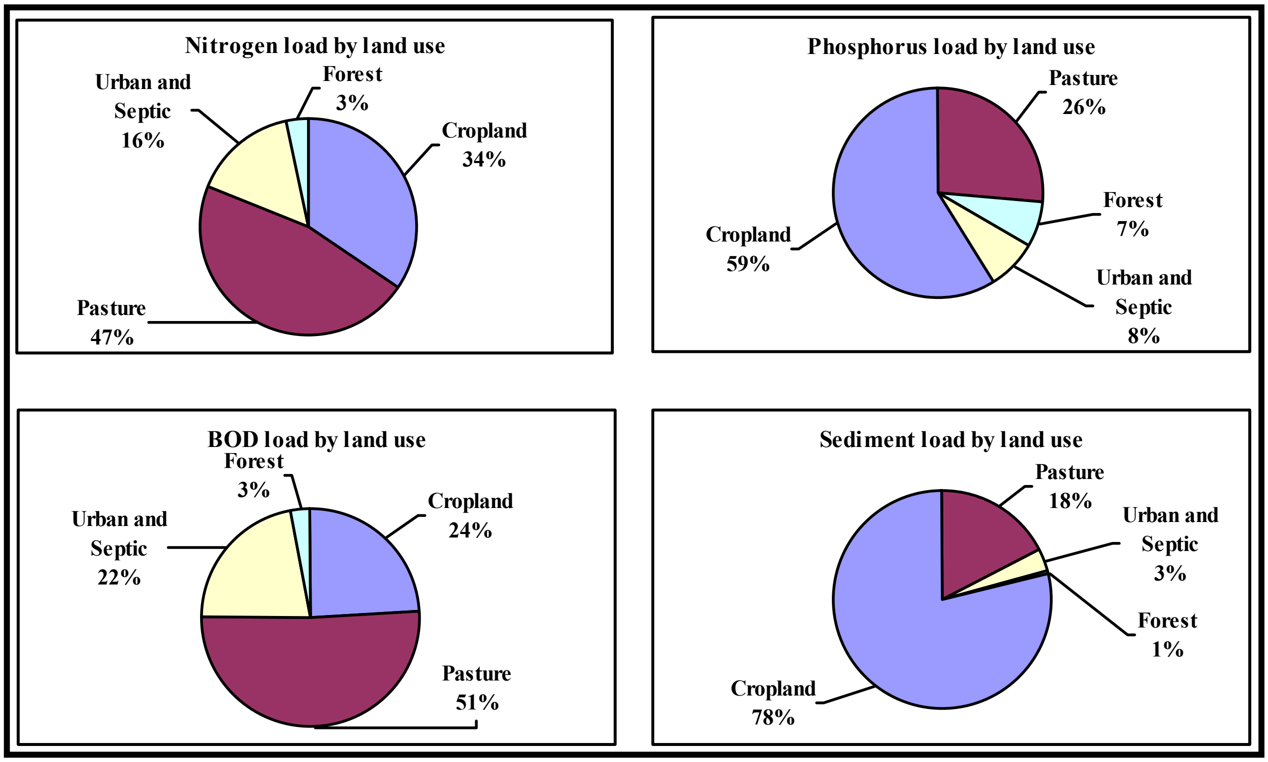

Figure 11. Sources of nitrogen, phosphorus, sediment, and BOD in the Shooter Ditch subwatershed.

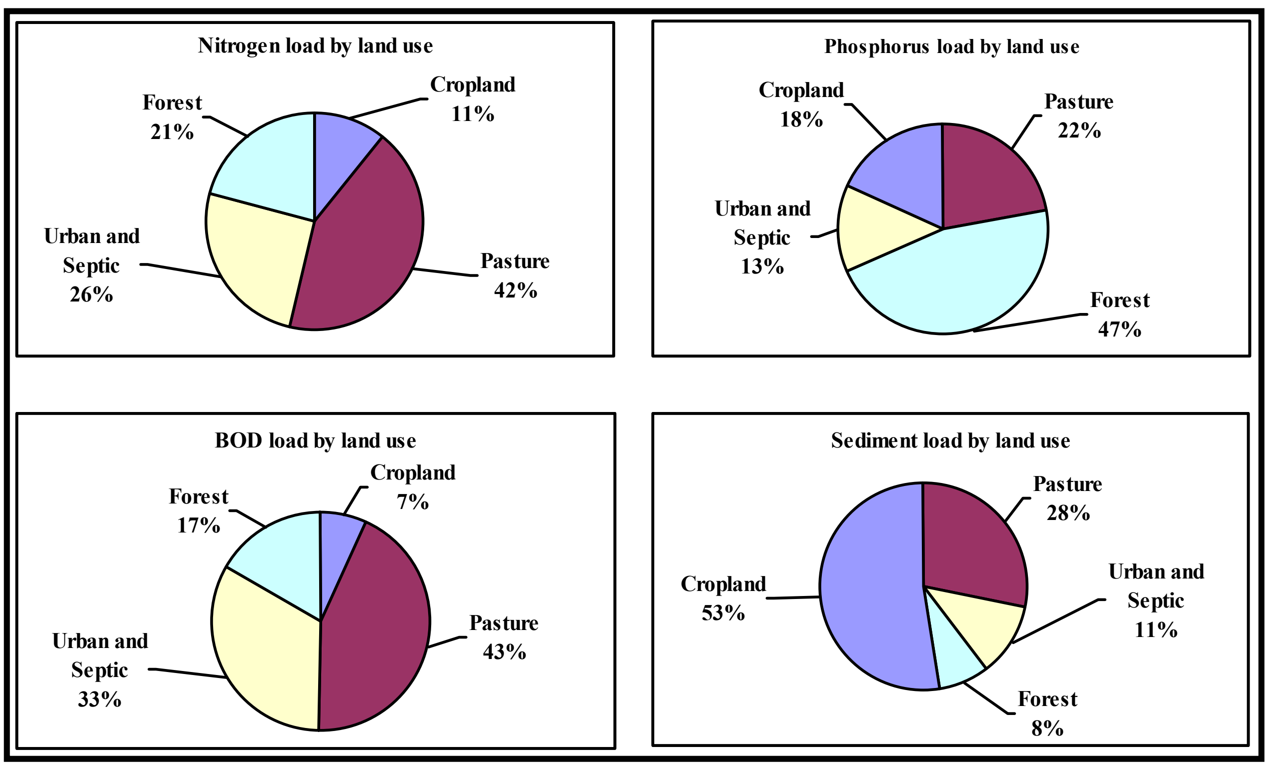

Figure 12. Sources of nitrogen, phosphorus, sediment, and BOD in the Suman Road Tributary subwatershed.

Modeling suggests that the Pope O'Connor Ditch subwatershed delivers a higher pollutant load for each pollutant modeled than the other three subwatersheds (Figures 1-4). This result is not surprising given that the Pope O'Connor subwatershed one of the largest subwatersheds. However, the magnitude of pollutant loading from the Pope O'Connor Ditch subwatershed is of concern. Despite being comparable in size to the Suman Road Tributary subwatershed, the Pope O'Connor Ditch subwatershed contributes more than twice the nitrogen, sediment, and BOD load and nearly twice the phosphorus load that the Suman Road Tributary subwatershed delivers. Additionally, while the Pope O'Connor Ditch subwatershed is only twice the size of the Johnson Ditch subwatershed, it contributes three to four times the more pollutants. Urban and agricultural land uses are responsible for the majority of the pollutant load in the Pope O'Connor subwatershed (Figure 10).

The water quality and biological integrity of the Pope O'Connor Ditch reflects the high pollutant loading it receives from its watershed. Pope O'Connor Ditch consistently exhibited the lowest dissolved oxygen concentrations. In July, dissolved oxygen levels in Pope O'Connor Ditch sank to 1.2 mg/L and the water column was only 16% saturated with oxygen. The high BOD loading to the ditch is likely responsible for the low oxygen concentrations observed in Pope O'Connor Ditch. Pope O'Connor Ditch also exhibited the poorest biological integrity of all the sampling sites. The high pollutant loading likely plays a role in preventing the establishment of a diverse, healthy biotic community. Sediment loading to the ditch also impairs the ditch's habitat, which in turn can negatively affect the biotic integrity of the ditch. The thick silt layers covering the Pope O'Connor Ditch channel clog fish and invertebrate gills, smother fish eggs, and reduce sight-seeing predators ability to find prey.

Despite being the smallest of the subwatersheds, the Shooter Ditch subwatershed delivers relatively high pollutant loads. Agricultural and pasture land uses contribute more pollutants that other land uses in the Shooter Ditch subwatershed (Figure 11). The Shooter Ditch subwatershed is slightly more than half the size of the Johnson Ditch subwatershed; yet it delivers more of the four pollutants modeled than the Johnson Ditch subwatershed (Figures 1-4). The Shooter Ditch subwatershed also contributes more sediment and nutrients (nitrogen and phosphorus) than the Suman Road Tributary subwatershed (Figures 1-3). The Shooter Ditch subwatershed contributes the greatest amount of phosphorus per acre of subwatershed (Figure 6). Additionally, per acre of subwatershed, Shooter Ditch contributes more sediment than the Pope O'Connor Ditch subwatershed (Figure 7). The thick silt layers covering the Shooter Ditch channel support the model's sediment loading results. A base flow total suspended solid concentration of 88 mg/L recorded in Shooter Ditch is also consistent with the model's results.

Relative to the Shooter Ditch subwatershed and the Pope O'Connor Ditch subwatershed, the Suman Road Tributary subwatershed and the Johnson Ditch subwatershed contribute lower pollutant loads to their respective creeks (Figures 1-4). Forested land covers a relatively large portion of these subwatersheds compared to the Shooter Ditch and Pope O'Connor Ditch subwatersheds. Forested land possesses lower curve numbers (has greater infiltration capacity) and lower pollutant concentrations in runoff than agricultural and urban land. Consequently, forested areas tend to deliver lower pollutant loads to nearby waterways compared to pollutant loads from other land uses.

The model may slightly underestimate the pollutant loading from the Suman Road Tributary subwatershed. The STEPL model utilizes countywide average USLE parameter values. These values may underestimate soil loss in morainal areas of the county, where steep topography increases the erodibility of the soil. Because a large portion of the Suman Road Tributary subwatershed lies in the Valparaiso Moraine, actual soil loss from the subwatershed may be greater than the modeled soil loss. The water quality sampling data supports this hypothesis. Following a storm event, the Suman Road Tributary exhibited the highest total suspended solids concentration of all the Coffee Creek tributaries. Additionally, by underestimating soil loss, the model likely also underestimates the other pollutant loading rates since the STEPL model factors in the soil's ability to transport pollutants. This potential underestimation of pollutant loading rates should be considered when using the model results to make management decisions.

Summary

The STEPL model was utilized as a screening tool to identify which subwatersheds are releasing the greatest pollutant loads from the Coffee Creek landscape. Results from the modeling exercise indicate that the Pope O'Connor Ditch subwatershed is contributing the greatest amount of nitrogen, phosphorus, oxygen demanding substances, and sediment to its respective tributary to Coffee Creek. Urban and agricultural land uses are responsible for the majority of the pollutant load in the Pope O'Connor subwatershed. When the model results are examined on "pollutant released per acre of subwatershed" basis, the Shooter Ditch subwatershed releases more phosphorus and sediment per acre of subwatershed than any of the other subwatersheds. Cropland in the subwatershed is the primary source of these pollutants. In general, the modeling results are consistent with qualitative observations, water quality analysis, and biotic integrity evaluations of each subwatershed's respective tributary. Pollutant loading from these subwatersheds may be impairing Coffee Creek's (mainstem) water quality, habitat, and biological communities. It is important to note, however, that it is unlikely that all of the pollutant load reaching each of Coffee Creek's tributaries reaches the mainstem. The tributaries and their respective biological communities assimilate some of the pollutant load. Based on the model results, watershed restoration efforts should target the Pope O'Connor Ditch and Shooter Ditch subwatersheds.

Literature Cited

U. S. Environmental Protection Agency. 1997. Compendium of Tools for Watershed Assessmnt and TMDL Development. United States Environmental Protection Agency, Office of Water, Washington, D. C. EPA 841-B-97-006.

APPENDIX I:

Potential Funding Sources

FUNDING SOURCES AND WATERSHED RESOURCES

Funding and other resources are important for the actual implementation of recommended management practices in a watershed. Several cost share and grant programs are available to help offset costs of watershed projects. Additionally, both human and material resources may be available in the watershed. The following is by no means an "all inclusive" list. Other funding opportunities and resources undoubtedly exist. These are merely a starting point for researching available grant resources.

Funding Sources

There are several cost-share grants available from both state and federal government agencies specific to watershed management. Lake associations and/or Soil and Water Conservation Districts (SWCDs) can apply for the majority of these grants. The main goal of these grants and other funding sources is to improve water quality though the use of specific BMPs. As public awareness shifts towards watershed management, these grants will become more and more competitive. Therefore, any association interested in improving water quality through the use of grants must become active soon. Once an association is recognized as a "watershed management activist" it will become easier to obtain these funds repeatedly. The following are some of the possible major funding sources available to lake and watershed associations for watershed management.

Lake and River Enhancement Program (LARE)

LARE is administered by the Indiana Department of Natural Resources, Division of Soil Conservation. The program's main goals are to control sediment and nutrient inputs to lakes and streams and prevent or reverse degradation from these inputs through the implementation of corrective measures. Under present policy, the LARE program may fund lake and watershed specific construction actions up to $100,000 for a specific project or $300,000 for all projects on a specific lake or stream. Cost-share approved projects require a 0-25% cash or in-kind match, depending on the project. LARE also has a "watershed land treatment" component that can provide grants to SWCDs for multi-year projects. The funds are available on a cost-sharing basis with farmers who implement various BMPs. The watershed land treatment program is recommended as a project funding source for the Coffee Creek watershed. More information about the LARE program can be found at http://www.in.gov/dnr/soilcons/programs/lare.

Clean Water Act Section 319 Nonpoint Source Pollution Management Grant

The 319 Grant Program is administered by the Indiana Department of Environmental Management (IDEM), Office of Water Management, Watershed Management Section. 319 is a federal grant made available by the Environmental Protection Agency (EPA). 319 grants fund projects that target nonpoint source water pollution. Nonpoint source pollution (NPS) refers to pollution originating from general sources rather than specific discharge points (Olem and Flock, 1990). Sediment, animal and human waste, nutrients, pesticides, and other chemicals resulting from land use activities such as mining, farming, logging, construction, and septic fields are considered NPS pollution. According to the EPA, NPS pollution is the number one contributor to water pollution in the United States. To qualify for funding, the water body must meet specific criteria such as being listed in the state's 305(b) report as a high priority water body or be identified by a diagnostic study as being impacted by NPS pollution. Funds can be requested for up to $300,000 for individual projects. There is a 25% cash or in-kind match requirement.

Section 104(b)(3) NPDES Related State Program Grants
Section 104(b)(3) of the Clean Water Act gives authority to a grant program called the National Pollutant Discharge Elimination System (NPDES) Related State Program Grants. These grants provide money for developing, implementing, and demonstrating new concepts or requirements that will improve the effectiveness of the NPDES permit program that regulates point source discharges of water pollution. Projects that qualify for Section 104(b)(3) grants involve water pollution sources and activities regulated by the NPDES program. The awarded amount can vary by project and there is a required 5% match.

Section 205(j) Water Quality Management Planning Grants
Funds allocated by Section 205(j) of the Clean Water Act are granted for water quality management planning and design. Grants are given to municipal governments, county governments, regional planning commissions, and other public organizations for researching point and non-point source pollution problems and developing plans to deal with the problems. According to the IDEM Office of Water Quality website: "The Section 205(j) program provides for projects that gather and map information on non-point and point source water pollution, develop recommendations for increasing the involvement of environmental and civic organizations in watershed planning and implementation activities, and implement watershed management plans. No match is required. For more information on the 319, 104(b)(3), and 205(j) grants, please see the IDEM website
http://www.in.gov/idem/water/planbr/wsm/205jmain.html.

Other Federal Grant Programs
The USDA and EPA award research and project initiation grants through the US National Research Initiative Competitive Grants Program and the Agriculture in Concert with the Environment Program.

Watershed Protection and Flood Prevention Program
The Watershed Protection and Flood Prevention Program is funded by the U.S. Department of Agriculture (USDA) and is administered by the Natural Resources Conservation Service (NRCS). Funding targets a variety of watershed activities including watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in small watersheds (250,000 or fewer acres). The program covers 100% of flood prevention construction costs or 50% of construction costs for agricultural water management, recreational, or fish and wildlife projects.

Conservation Reserve Program
As already discussed, the Conservation Reserve Program (CRP) is funded by the USDA and administered by the Farm Service Agency (FSA). CRP is a voluntary, competitive program designed to encourage farmers to establish vegetation on their property in an effort to decrease erosion, improve water quality, or enhance wildlife habitat. The program targets farmed areas that have a high potential for degrading water quality under traditional agricultural practices or

areas that might make good wildlife habitat if they were not farmed. Such areas include highly erodible land, riparian zones, and farmed wetlands. Currently, the program offers continuous sign-up for practices like grassed waterways and filter strips. Participants in the program receive cost share assistance for any plantings or construction as well as annual payments for any land set aside.

Wetlands Reserve Program

The Wetlands Reserve Program (WRP) is funded by the USDA and is administered by the NRCS. WRP is a subsection of the Conservation Reserve Program. This voluntary program provides funding for the restoration of wetlands on agricultural land. To qualify for the program, land must be restorable and suitable for wildlife benefits. This includes farmed wetlands, prior converted cropland, farmed wet pasture, farmland that has become a wetland as a result of flooding, riparian areas which link protected wetlands, and the land adjacent to protected wetlands that contribute to wetland functions and values. Landowners may place permanent or 30-year easements on land in the program. Landowners receive payment for these easement agreements. Restoration cost-share funds are also available. No match is required.

Partners for Fish and Wildlife Program

The Partners for Fish and Wildlife Program (PFWP) is funded and administered by the U.S. Department of the Interior through the U.S. Fish and Wildlife Service. The program provides technical and financial assistance to landowners interested in improving native habitat for fish and wildlife on their land. The program focuses on restoring wetlands, native grasslands, streams, riparian areas, and other habitats to natural conditions. The program requires a 10 year cooperative agreement and a 1:1 match.

North American Wetland Conservation Act Grant Program

The North American Wetland Conservation Act Grant Program (NAWCA) is funded and administered by the U.S. Department of Interior. This program provides support for projects that involve long-term conservation of wetland ecosystems and their inhabitants including waterfowl, migratory birds, fish, and other wildlife. The match for this program is on a 1:1 basis.

National Fish and Wildlife Foundation (NFWF)

The National Fish and Wildlife Foundation is administered by the U.S. Department of the Interior. The program promotes healthy fish and wildlife populations and supports efforts to invest in conservation and sustainable use of natural resources. The NFWF targets six priority areas which are wetland conservation, conservation education, fisheries, neotropical migratory bird conservation, conservation policy, and wildlife and habitat. The program requires a minimum of a 1:1 match. More information can be found at http://www.nfwf.org/about.htm.

Community Forestry Grant Program

The U.S. Forest Service through the Indiana Department of Natural Resources Division of Forestry provides three forms of funding for communities under the Community Forestry Grant Program. Urban Forest Conservation Grants are designed to help communities develop long term programs to manage their urban forests. UFCG funds are provided to communities to improve and protect trees and other natural resources, projects that target program development, planning, and education are emphasized. Local municipalities, non-for-profit organizations, and state agencies can apply for $2,000-20,000 annually. The second type of Community Forestry Grant Program, the Arbor Day Grant Program, funds target activities which promote Arbor Day and the planting and care of urban trees. $500-1000 grants are generally awarded. Tree Steward Program is an educational training program that involves six training sessions of three hours each. The program can be offered in any county in Indiana and covers a variety of tree care and planting topics. Generally, $500-1000 is available to assist communities in starting a county or regional Tree Steward Program. Each of these grants requires an equal match.

Wildlife Habitat Incentive Program
The Wildlife Incentive Program (WHIP) is funded by the USDA and administered by the NRCS. This program provides support to landowners to develop and improve wildlife habitat on private lands. Support includes technical assistance as well cost sharing payments. Those lands already enrolled in WRP are not eligible for WHIP. The match is 25%.

Forestry Incentives Program
The NRCS Forestry Incentives Program (FIP) provides cost-share dollars for forestry conservation activities like tree planting and timber stand improvement on privately-owned forest land. The program will share up to 65% of the cost of these and other related practices up to $10,000 per landowner per year. To be eligible for FIP, a particular parcel of land must be: smaller than 1,000 acres, be privately owned and non-industrial, be suitable for land management practices like reforestation or stand improvement, and be of sufficient productivity to yield marketable timber crops.

Environmental Quality Incentives Program
The Environmental Quality Incentives Program (EQIP) is a voluntary program designed to provide assistance to producers to establish conservation practices in target areas where significant natural resource concerns exist. Eligible land includes cropland, rangeland, pasture, and forestland, and preference is given to applications which propose BMP installation that benefits wildlife. EQIP offers cost-share and technical assistance on tracts that are not eligible for continuous CRP enrollment. Certain BMPs receive up to 75% cost-share. In return, the producer agrees to withhold the land from production for five years. Practices that typically benefit wildlife include: grassed waterways, grass filter strips, conservation cover, tree planting, pasture and hay planting, and field borders. Best fertilizer and pesticide management practices are also eligible for EQIP cost-share.

Farmland Protection Program
The Farmland Protection Program (FPP) provides funds to help purchase development rights in order to keep productive farmland in use. The goals of FPP are: to protect valuable, prime farmland from unruly urbanization and development; to preserve farmland for future generations; to support a way of life for rural communities; and to protect farmland for long-term food security.

Debt for Nature
Debt for Nature is a voluntary program that allows certain FSA borrowers to enter into 10-year, 30-year, or 50-year contracts to cancel a portion of their FSA debts in exchange for devoting eligible acreage to conservation, recreation, or wildlife practices. Eligible acreage includes:

wetlands, highly erodible lands, streams and their riparian areas, endangered species, or significant wildlife habitat, land in 100-year floodplains, areas of high water quality or scenic value, aquifer recharge zones, areas containing soil not suited for cultivation, and areas adjacent or within administered conservation areas.

Non-Profit Conservation Advocacy Group Grants
Various non-profit conservation advocacy groups provide funding for projects and land purchases that involve resource conservation. Ducks Unlimited and Pheasants Forever are two such organizations that dedicate millions of dollars per year to projects that promote and/or create wildlife habitat.

U.S. Environmental Protection Agency Environmental Education Program
The USEPA Environmental Education Program provides funding for state agencies, non-profit groups, schools, universities to support environmental education programs and projects. The program grants nearly $200,000 to projects throughout Illinois, Indiana, Michigan, Minnesota, Wisconsin, and Ohio. More information is available at http://www.epa.gov/region5/ened/grants.html.

Coastal Zone Management Funds
Coastal Zone Management funding is available for projects that focus on finding local solutions to coastal problems such as coastal wetland management and protection, management of polluted runoff, sediment and erosion control reduction, assessment of impacts of coastal zone growth and development, and demonstration projects with potential to improve coastal zone management. Granting is provided as formula grants which do not require a federal match and as program enhancement funds where no match of any type is required. More information on Coastal Zone Management grants can be obtained from http://www.nos.noaa.gov/programs/ocrm.html.

Great Lakes Basin Program for Soil Erosion and Sediment Control
The Great Lakes Program supports annual competitive grants that target erosion and sediment control projects. The Program funds projects comprising the following three elements: program and technical assistance, demonstration projects, and information and education. The projects generally address urban, agricultural, streambank, shoreline, and forest erosion. The Great Lakes Basin Program provides approximately $15,000-40,000 for 20 projects located throughout the Great Lakes region. More information on the Great Lakes Basin Program for Soil Erosion and Sediment Control can be located at http://www.glc.org/basin.

Great Lakes Protection Fund
The Great Lakes Protection Fund is a private, nonprofit corporation founded by the governors of the Great Lakes states. The permanent environmental endowment supports collaborative actions to improve the health of the Great Lakes ecosystem. Current fund interests include preventing biological pollution, restoring natural flow regimes, and using market mechanisms for environmental improvement. Grants are not currently available for projects located in Indiana because Indiana has not yet contributed to this fund. More information on the Great Lakes Protection Fund can be found at http://www.glpf.org.

The Joyce Foundation

The Joyce Foundation supports efforts in six program areas: Education, Employment, Environment, Gun Violence, Money and Politics, and Culture. The primary focus of the Environment program is protecting the natural resources of the Great Lakes Region. The Foundation supports the development, testing, and implementation of policy-based, prevention-oriented, scientifically sound solutions to environmental issues affecting the Great Lakes. Two of the key focuses of the Foundation are protecting and improving Great Lakes water quality and maintaining and strengthening the network of Great Lakes associated environmental groups. Additional information about grant funding opportunities provided by The Joyce Foundation can be found at http://www.joycefdn.org.

NiSource Environmental Challenge Fund

The Environmental Challenge Fund is an employee-driven, non-for-profit corporation created by NiSource. The corporation provides funds to stimulate local efforts to preserve, protect, and enhance the environment in the service area of NiSource subsidiaries. Since its inception the Environmental Challenge Fund has provided funding for over 100 projects totaling more than $280,000. More information is available at http://www.nisource.com/enviro/ecf.asp

Indianapolis Power and Light Company (IPALCO) Golden Eagle Environmental Grant

The IPALCO Golden Eagle Grant awards grants of up to $10,000 to projects that seek improve, preserve, and protect the environment and natural resources in the state of Indiana. The award is granted to approximately 10 environmental education or restoration projects each year. Deadline for funding is typically in January. More information is available at http://www.ipalco.com/ABOUTIPALCO/Environment/Golden_Eagle.html

Nina Mason Pulliam Charitable Trust (NMPCT)

The NMPCT awards various dollar amounts to projects that help people in need, protect the environment, and enrich community life. Prioritization is given to projects in the greater Phoenix, AZ and Indianapolis, IN areas, with secondary priority being assigned to projects throughout Arizona and Indiana. The trust awarded nearly $20,000,000 in funds in the year 2000. More information is available at www.nmpct.org

Watershed Resources

An important but often overlooked factor in accomplishing goals and completing projects in any watershed is resources within the watershed itself. These resources may be people giving of their time, local schools participating in projects, companies giving materials for project construction, or other donations. This study documents some of these available resources for the Coffee Creek watershed. It is important to note that this list is not all-inclusive, and some groups and donors may have been missed.

Watershed Coordinator

IDEM and the USDA cosponsor three regional watershed conservationist positions. The watershed conservationist is an advocate for watershed level work in the region. Watershed conservationists can help direct actions of groups and stakeholders who are interested in working together to address problems in their watershed. They can help with everything from structuring public meetings to assisting with the compilation of a Watershed Management Plan. Their wealth of knowledge includes ideas about how to work with and respect all stakeholders in order to find the best plan for natural resource conservation within your watershed. Matt Jarvis is the regional watershed conservationist for the northern third of Indiana and has an office in Delphi, Indiana. His contact information is: Matt Jarvis, Regional Watershed Conservationist, Natural Resources Conservation Service, 1523 N. US Highway 421, Suite 2 Delphi, Indiana 46923-9396. He can also be contacted via phone at (765) 564-4480 or email at matt.jarvis@in.usda.gov.

Coordinated Resource Management
The Coordinated Resource Management (CRM) process is an organized approach to the identification of local concerns, evaluation of natural resources, development of alternative actions, assistance from technical specialists, implementation of a selected alternative, evaluation of implementation activities, and involvement of all interested parties who wish to participate in watershed action. The goal of the CRM process is the development of an effective Watershed Management Plan. Further CRM information and its complementary Watershed Action Guide can be downloaded from the USDA/NRCS website at http://www.in.nrcs.gov. The CRM gives guidance on how diverse groups of people can plan to maximize benefits to the greatest number of individuals while enhancing or maintaining the natural resource.

Hoosier Riverwatch
The Hoosier Riverwatch Program was started in 1994 by the State of Indiana to increase public awareness of water quality issues and concerns. Riverwatch is a volunteer stream monitoring program sponsored by the IDNR Division of Soil Conservation in cooperation with Purdue University Agronomy Department. Any citizen interested in water quality may volunteer to take a short training session held from May through October. Water monitoring equipment may be supplied to nonprofit organizations, schools, or government agencies by an equipment grant. Additionally, many SWCD offices (including the Porter County SWCD) have loaner equipment that can be borrowed. The Coffee Creek Watershed Conservancy and Chesterton High School currently participate in the program. More detailed information is available via the Hoosier Riverwatch web site at http://www.state.in.us/dnr/soilcons/riverwatch/.

Volunteer Groups
Volunteer groups can be instrumental in planning projects, implementing projects, and monitoring projects once they are installed. The Coffee Creek Watershed Conservancy and Chesterton High School have both participated in the Hoosier Riverwatch program. Involving the people living in the watershed, especially school-age children, is a good way to promote natural resource awareness and a good way to get data collected and projects completed. Oftentimes, data collected by volunteer groups may be the only available data for a watershed. This data is very valuable in helping to establish baseline trends with which to compare future samples.

APPENDIX J:

Action Register

Action Register

Date: ____

Goal (choose from goals listed below): ____

Task completed: ____

Type of task (circle appropriate task type):

Meeting Who attended by: ____

Education Number attended: _____ Number distributed: _____
Distributed to: ____

Investigation Sources of information: ____

Field Work

Other

Provide a description of the task in the space below. Please include what portion of the goal(s) or objective(s) this task completes, a listing of other actions required based on this task, and any suggested future actions.

Additional notes:

Task completed by:____________________________________

Goals:
Hire watershed coordinator
Streamside buffer establishment/protection
Forested land conservation
Stakeholder education
E. coli source identification
Subsurface drain load determination
Sediment and nutrient load reduction from Pope O'Connor Ditch
Sediment and nutrient load reduction from Shooter Ditch